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Forthcoming Events.

SEPTEMBER 27.

Institute of British Foundrymen (Newcastle Branch):—Annual meeting.

SEPTEMBER 30.

Institute of Marine Engineers:—Ordinary meeting in London. "Marine Oil Engines: Practical Notes on Bearing Adjustment," Paper by John Lamb.

THE FOUNDRY TRADE JOURNAL IS THE OFFICIAL ORGAN OF THE

INSTITUTE OF BRITISH FOUNDRYMEN AND THE WELSH ENGINEERS' AND FOUNDERS' ASSOCIATION.

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Foundry Exhibitions.

The letter from Mr. A. S. Beech, a director of the Universal System of Machine Moulding and Machinery Company, Limited, which is printed elsewhere in this issue, probably represents the general opinion of the foundry equipment and supply concerning exhibitions which are organised periodically and apparently haphazardly by any person or body who feels so disposed. Dismissing the American Foundrymen's Association exhibitions as not being relative, the following foundry exhibitions have been staged: Agricultural Hall, 1912; Liège, 1921; Birmingham, 1922; Paris, 1923; Birmingham, 1924. The 1922 and 1923 shows were contemporaneous with representative and established foundry technical congresses, and were probably the most successful. At the termination of the Birmingham 1922 Exhibition, a number of the exhibitors met and expressed a desire for a rotorary system which would ensure an exhibition being held triennially in Great Britain and France and quinquennially in Belgium, *but in connection with international technical congresses.* France and Belgium are able to utilise their technical organisations to this end, but the Institute of British Foundrymen is definitely precluded from such a work. A few weeks ago we announced that Mr. F. W. Bridges intended to organise a foundry exhibition in 1926 on the lines of his previous one in 1912 at the Agricultural Hall to be contemporaneous with the annual meeting of the Institute of British Foundrymen, which is expected to be held in London that year. This was quickly followed by an announcement from the Birmingham Chamber of Commerce that they, too, intended staging a similar exhibition in Birmingham during the same year.

Mr. Bridges then cancelled his arrangements with the Agricultural Hall authorities, so leaving the field free for Birmingham. Even assuming that all this has been done in the best interests of the foundry trade and its suppliers, it needs their endorsement. Because of the diverse nature of their manufactures, ranging as they do from pig-iron to grinding machines, they can never possess a permanent organisation worth anything; no real bond can exist. If, however, our correspondence shows that they object to being driven sheep-like, we will call a meeting in the near future to deal with the present situation, and if a mandate is forthcoming, take steps in the future, as and when occasion arises, to safeguard their interests and those of the foundry trade with which they are so closely allied.

There is no good reason why the various individuals or bodies who have in the past or may in the future organise foundry exhibitions should regard this move unfavourably, because they will know in advance whether they have the enthusiastic following of the trade or what can amount to a measure of *force majeure* support, liable on the slightest pretext to resolve itself into a dissatisfied crowd.

Held at appropriate places, periods and seasons, foundry exhibitions do much good for the industry, but when staged too often there are too few new features to make attendance worth while. Held in a place which is adversely affected by contemporaneous events elsewhere is courting disaster, and the choice of a season, such as just before the holidays, when enquiries are likely to be shelved, is bad business. Certainly, in the past, there has been a certain amount of consultation as to these factors, but the range of discussion has been definitely circumscribed—a matter to be avoided in the future.

Manufacture of Cast-Iron Pipe in the South of the United States.*

By Richard Moldenke, E.M., Ph.D., Watchung, N.J.

No single branch of the foundry industry has been brought to a production basis of huge tonnage, low manufacturing cost, and producing material of a remarkably high quality, as has the making of cast-iron pipe. The pipe shop is an excellent illustration of the fact that repetition work in specialties leads to mechanical equipment and manipulation that lower production costs to an astonishing degree. Hence cast-iron pipe, in dull times, has been sold at a few dollars a ton over the selling price of the pig-iron used. On the other hand, these same pipe shops make fittings of many varieties, and in much smaller quantities, where the cost is high, and when pipe may be sold, say, at $50 a ton, the fittings on the same shipment will be sold for nearly double that price.

The history of pipe-making in the United States is a chequered one—the mortality of plants is high and, from the nature of the industry, plants must be large to live. In spite of the fact that the best processes must be used to turn out this rather strict specification material, pipe is easy to make and a pipe plant is more of a tonnage mill than the really high-class specialty foundry it should be. Every time, therefore, that the demand for pipe is strong new shops spring up, only to close when the demand has ceased, but the financial damage to the more permanent plants has been done. Both the South and the North have had abundant experiences of this kind, and when recently a northern Public Service Corporation gave its order to France, the pipe plants thus adversely affected were content to have this occur rather than see a plant started to supply the surplus demand.

The heavy fluctuations in the production of cast-iron pipe, because of the alternation of bad and good times in America, also the irregularity with which orders are placed for extension requirements of the large municipal water-supply developments, have tended to put out of business all those establishments that were not advantageously situated for either rock-bottom cost of supplies, or specially good shipping facilities. Thus, while the Southern plants, located in the Birmingham district, have the advantage of cheap pig-iron, coke and labour, those of the Delaware River can ship by water all over the world. To obtain a steadier production, individual manufacturers have tried to branch out into special lines—to have cast-iron pipe replace steel pipe. Much of the conduit work in oil refineries is made of cast iron, for corrosive waters, even where high pressure is involved, cast iron does better than steel, and for some purposes cast-iron pipe is now furnished with a cement lining.

Centrifugal Pipe.

Perhaps the most striking development in recent years in this industry has been the manufacture and introduction of centrifugally cast pipe. Two distinct methods are now in use, and both are in daily operation on a commercial scale so far only in Birmingham, Ala. The original plant of the first process introduced in the United States is at Burlington, N.J.; it is understood that this plant is to be greatly enlarged in the immediate future. This process is named from its inventor, de Lavaud, and consists in rotating a steel mould at high rate of speed, introducing therein the proper quantity of molten iron, which through centrifugal force is spread over the mould and thus makes the pipe. The other centrifugal process, the so-called sand-spun method, substitutes a sand-lined mould for the steel in the de Lavaud method: it thus gets a closer approximation to the old way of making pipe. Both methods obviate the use of cores. The chilling effect of the steel mould on the molten iron is overcome by a subsequent short anneal at high temperature.

The use of centrifugally cast-iron pipe is spreading rapidly. The idea is old, for patents in England date back a hundred years. The developments, however, were never successful commercially, until de Lavaud worked out a combination of detailed operations that overcome the difficulties of pouring iron into a metal mould and getting serviceable results. The main trouble was to get the molten metal spread evenly over the inner surface of the rapidly revolving steel mould within the time available before this metal would set. The object was accomplished by introducing, all the way into the mould, a refractory-lined spout which carried the molten metal from the special ladle that it held the right amount of iron, and withdrawing it at a uniform speed while the metal was flowing into the mould. This gave a flat spiral of metal which remained fluid long enough to have the edges jointed without a "cold shut" and thus made a perfect pipe. The indications of this spiral formation can be seen on the inner surface of the pipe.

The bell end of the pipe is fashioned by placing a core of the proper shape in the far end of the mould; to allow withdrawal after setting, the spigot end of the pipe is left straight. A groove can be cut into the pipe subsequently to provide for the joint. The mould is made of nickel-chrome steel with about 0.30 per cent. carbon, and is revolved by a Pelton wheel attachment, which allows great flexibility in operation. Cammen has given a formula for the speed of revolution for pipe of various diameters, thus:—

$$\text{R.p.m.} = \frac{1550}{\sqrt{R}},$$ in which R is the inner radius of the mould.

At the present time, centrifugal pipe is made in sizes from 6 in. to 12 in. in diameter, and preparations are under way to make 4-in. pipe.

Operation Difficulties.

In operation two points of the apparatus need close attention: (1) The roller bearings of the mould require the best skill of the steel metallurgist and heat-treater in their production. (2) The moulds, through constant heating and cooling of the inner surface, develop fire cracks, which eventually make the withdrawal of the pipe difficult; hence their life is limited, though some astonishingly long runs have been recorded. As the pipes are withdrawn from the moulds they roll automatically into the annealing oven, where they remain for 20 min. The oven is maintained at a temperature of 1,750 deg. F. The revolving of the pipe prevents bending.

From the nature of the process, the walls of the pipe are not thick; the carrying capacity of the steel mould in withdrawing heat is overtaxed when too much metal is introduced, thus time is lost in the final setting of the excess metal. On the other hand, centrifugally cast metal is very dense and sound, so that the strength is higher; while through a subsequent anneal the machinability of the metal is restored when the metal mould has been used. The density and nature of the metal, it is claimed, retard the influences for corrosion of the pipe, so that the risk otherwise taken in laying many miles of a lighter pipe may not be serious. The future alone can show if this is so.

Relative Costs.

Centrifugally cast pipe has a manufacturing cost fully as large as that of sand-cast pipe, for while the core is obviated the use of metal moulds means an annealing expense. Further, there is the royalty under the several patents. The advantages of centrifugally cast-iron pipe, with steel moulds, are: (1) Because of its lightness more miles of the pipe may be laid for the same cost; (2) higher quality of the metal, all impurities being driven inward as the metal sets against the metal mould surface, as also from centrifugal action; (3) less corrodibility; (4) avoidance of a core; (5) reduction of labour in manufacturing; (6) saving in foundry space. The disadvantages

* A Paper to be presented to the American Institute of Mining and Metallurgical Engineers.

would seem to be: (1) The possibility that improperly annealed pipe can get through occasionally; (2) that it is not a convenient commercial proposition to make this kind of pipe thick; (3) that the corrodibility cannot be determined satisfactorily for a number of years; (4) that the testing of this class of pipe is still unsolved. These objections by no means militate against the development of this product, but are given to show that side of the problem. It is unquestionably true that cast iron, when poured into a metal mould, does not get the same chance for the unrestricted development of its physical qualities as when going into sand moulds.

Sand-Spun Pipe.

The sand-spun cast-iron pipe is just appearing on the market. Here the revolving mould consists of a steel container (flask) lined with sand of the kind ordinarily used in the pipe foundry. Cores for bell and spigot are placed in the ends of the mould and the metal is poured into the mould without the use of a special spout, as the iron has time to spread properly before setting. The somewhat damp sand surface of the mould is dusted automatically with a little cement, which hardens the surface sufficiently to withstand the cutting of the molten iron until the velocity of the mould has been acquired. When set, the pipe is withdrawn with the destruction of the sand lining of the mould, so that the mould must be relined each time with new sand. But the iron has the advantage of setting as it would in the ordinary sand casting process, apart from the centrifugal action on the metal itself. In this process, also, no core is used, in addition no annealing is necessary.

The process, while turning out pipe commercially, is not fully developed, as two points require some special safeguarding. Thus, when the ladle of metal is poured into the mould in either the revolving or from the quiet state into the revolving, it takes a little time for the molten iron to acquire the same velocity as the mould; during this period the iron repeatedly drops back into the pool on the bottom. This effect, and the time required for the metal to set, which is greater than when iron goes into a metal mould, approximate what happens when iron is poured into an open-sand mould. There is more or less surface oxidation, with bad-looking surfaces resulting. Inasmuch as slag and dirt are forced inward through centrifugal action, the inner pipe surface is affected correspondingly. For marketing the pipe, the pipe is lined with cement, which is fastened securely to the pipe by reason of this roughness.

The advantages of the "sand-spun" cast-iron pipe seem to be the following: (1) Molten metal gets time to set properly, as in sand moulds; (2) added advantage of density from centrifugal action; (3) avoidance of the core by the centrifugal method; (4) ability to make thick pipe if desired, and to have a spigot end; (5) no special difference in corrodibility as compared with ordinary cast-iron pipe, nor requirement of higher silicon, as with the de Lavaud method; (6) annealing is not necessary; (7) some labour reduction over ordinary sand method. The disadvantages are: (1) Because of the time of setting, considerable surface oxidation takes place, making the pipe interior rough; (2) necessity, until process has been developed further, of cement coating of interior, though this, in itself, is an advantage where cement-lined pipe is desired.

The future development of these two basic processes will be watched with the greatest of interest, as huge values are involved, and the material and product enter civilised life so vitally. For the moment the tonnage, though respectable, is but a small part of the production of this branch of the foundry industry, and centrifugal cast-iron pipe is made—so far as the writer is aware—only in Great Britain, the United States and Canada. Germany is testing a development similar to that of de Lavaud, so far as one hears of it; France and Belgium have not entered this field commercially.

The total production of American cast-iron pipe in 1921 could be set at 800,000 tons, of which 250,000 tons were used as soil pipe and for conveying gas; 550,000 tons were used as water pipe, of which half was used in large city water-supply work. At present the output of the American plants (all of them are now running practically full) is 50 per cent. higher, or probably on the basis of 1,200,000 tons per annum total. The distribution percentage is about on the same basis as it was for 1921.

The Southern plants, with their estimated capacities for water and gas pipe, are as follows:—

	Tons per annum.
Plants of the United States Cast Iron Pipe & Foundry Company, at Birmingham, Anniston, Bessemer, Ala., and Chattanooga, Tenn. ...	400,000
American Cast Iron Pipe Company, Birmingham, Ala.	120,000
National Pipe & Foundry Company, Birmingham, Ala.	60,000
Lynchburg Foundry Company, Anniston Plant, Ala.	25,000
Total	605,000

It is estimated that the northern and the southern production capacity are about equal at the present time, with contemplated large additions for centrifugally cast pipe in the North.

Institute of British Foundrymen.

LANCASHIRE BRANCH.

Visit to Warrington Works.

Some 80 members and friends of the Lancashire Branch of the Institute of British Foundrymen visited Warrington on Saturday, September 6, and by the kindness of the Richmond Gas Stove and Meter Company, Limited, were enabled to inspect their Grappenhall Works. The Company arranged for the visitors to be conveyed from Warrington Station to the Works, and after a photograph of the group had been taken, the managing director of the Company, Mr. J. W. Slack, addressed the party in the board room.

The Works was toured under the guidance of Mr. Slack; Mr. Langford, the works manager; Mr. W. H. Sherburn; and Mr. H. Sherburn, the foundry manager.

The Richmond Company's foundry is very extensive, and has been built and laid out for the repetition production of light castings of fine finish. Particular interest was shown in a new cupola which is being installed. The new furnace is designed for hot melting and for continuous output. Much interest was taken in the core-making department and in the department which is set aside for the making of pattern plates.

In addition to the foundry, the visitors were shown through the machining and assembly departments, and the departments that are set aside for the grinding and enamelling of castings. This latter process is unique, and aroused very considerable interest.

At the conclusion of the tour the party was entertained to tea by the Company. After tea the Branch President, Mr. R. A. Miles, expressed the appreciation of the visitors as foundrymen of the very efficiently laid out and conducted foundry that they had had the privilege of inspecting. He also moved a vote of thanks to the Richmond Company and to the members of the staff. In seconding the vote of thanks, Mr. R. W. Kenyon, an ex-President of the Lancashire Branch, remarked upon the very high finish which the Richmond Company succeeded in obtaining on their castings. Both mover and seconder referred to the work of Mr. W. H. Sherburn, who was formerly the chief designer of the Richmond Company, and who, although retired, is now retained in a consultative capacity. Mr. Sherburn was practically the founder, and was the first President of the Lancashire Branch, and in 1923 was the recipient of the Oliver Stubbs Gold Medal. His son, Mr. H. Sherburn, is now the Company's foundry manager.

Mr. J. W. Slack, the managing director, responded to the vote of thanks, and spoke in eulogistic terms of the work of the Institute and of the Company's pleasure in having them as guests. Mr. Langford, the works manager, also replied to the vote of thanks.

XUM

Correspondence.

[We accept no responsibility for the statements made or the opinions expressed by our correspondents.]

The Nature of the Phosphide Eutectic.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—I was much amused by the letter and photomicrograph in your issue of September 4 on the nature of the phosphide eutectic. Surely Dr. Rogers has not only just become aware of the nature variability of the phosphide eutectic in cast iron.

The structure Dr. Rogers exhibits has been

FIG. 1.—BINARY PHOSPHIDE EUTECTIC × 1,000.

shown and explained many years ago—at least sixteen—for instance, by Gutowsky in "Metallurgie," 1908, vol. 5, p. 493.

The accompanying photomicrographs were taken by myself many years ago (not, however, with a "super" microscope), and show two of the possible variations in constitution of the phosphide eutectic. No. 1 (at a magnification of 1,000 dias.) was from a very slowly-cooled dry-sand casting, which contained only 0.11 per cent. combined carbon. The phosphide eutectic is in the final equilibrium stage, *i.e.*, the binary eutectic of ferrite and phosphide. No. 2 shows a more common

FIG. 2.—TERNARY PHOSPHIDE EUTECTIC × 1,000.

appearance—the semi-equilibrium stage, *i.e.*, phosphide with nodules containing pearlite-laminæ enclosed. Possibly the phosphide itself contained plates of carbide (which would be shown by heat tinting), but it is so long ago since these were taken that I have forgotten. In chilled cast iron (such as chilled rolls) the nodules are structureless, due to the retention of the austenitic phase. The structure depends entirely on the rate of cooling and the composition—very slow rates of cooling resulting in complete diffusion of the carbide from the eutectic and its decomposition into graphite and ferrite.—Yours, etc.

FRANCIS W. ROWE.

41, Moorside Avenue, Crosland Moor,
Huddersfield.
September 18.

Foundry Exhibitions.

To the Editor of THE FOUNDRY TRADE JOURNAL.

SIR,—We see from your issue of September 11, No. 421, that the Birmingham Chamber of Commerce has decided again to organise the International Foundry Trades Exhibition in 1926 upon the same lines as the two previous Exhibitions held in 1922 and 1924.

As fairly large exhibitors at the Exhibitions held in 1922 and 1924, we desire to lodge a formal protest against the policy of the Birmingham Chamber of Commerce.

We feel that the Birmingham Chamber of Commerce should not be the body to dictate to the makers of foundry plant as to when and where they should exhibit their manufactures. We as a Company firmly believe also that it would be to the benefit of all parties concerned if this Exhibition was to be held at the same time and in the same town as the usual yearly Foundry Congress associated with the Institute of British Foundrymen. In 1922, we believe it was quite a good policy to have the Foundry Trades Exhibition in Birmingham, because the yearly Congress was held in that city, and we speak from practical experience when we say we got many more visitors in 1922 from all over the country than we did in 1924 when there was no Foundry Congress.

It would appear that foundrymen have the choice of going to the Congress or to the Exhibition, and some choose the Congress and others choose the Exhibition, whereas if the two had been held simultaneously in the same town it would have been possible for foundrymen to visit both. Added to this, we consider that the exhibitors themselves should decide when the Exhibition is to be held, and, moreover, in which town, and with this end in view, we propose to circularise all the exhibitors at the recent Foundry Exhibition in Birmingham and place these views before them. We have no wish at all to interfere with the intentions of the Birmingham Chamber of Commerce, but we feel that as exhibitors, and large exhibitors, we have a right to be consulted on this very important matter.—Yours, etc.

FOR THE UNIVERSAL SYSTEM OF MACHINE MOULDING AND MACHINERY COMPANY, LIMITED,

A. S. BEECH.

97, Queen Victoria Street, London, E.C.4.
September 19, 1924.

THE s.s. "Don," the second of the two cargo and passenger steamers ordered by the London, Midland & Scottish Railway Company from Vickers, Limited, in December last, for their Goole and Continental Service, was launched from the Naval Construction Works at Barrow-in-Furness last Thursday. The first of these two steamers, the s.s. "Dearne," which was launched on July 21, has just completed her sea trials and has been handed over to the owners.

An Engineering Diary.—The 1925 issue of this well-known diary, written by Mr. J. E. Dodsworth, is now in the press and will be published shortly at 3s. net by Charles Letts and Company, Southwark Bridge Buildings, London, S.E.1. The usual three sections are being retained, viz., the diary portion proper, 7 days to a page; the general business information section (32 pages); and the engineering section of 48 pages. This part contains a considerable collection of useful tables, data, and other information of distinct value to the engineer, chemist, etc., and of which he stands in constant need.

Recent Developments in Firing Mould and Core Stoves.

At a meeting of the Refractory Materials Section of the Ceramic Society, held at the British Empire Exhibition, Wembley, last Thursday, Mr. T. W. Barley (Engineer to Edgar Allen & Company, Limited, of Sheffield) read a paper on the above subject, and also described the construction and operation of the Huttenes coke-fired air-blown furnace. The continuous advance in the price of fuel, he said, together with a contracted market for the finished steel product, compelled the attention of the iron and steel founder to every possible means of effecting economies in the consumption of fuel—one of the heaviest items of expenditure in the production of steel. The cost of drying moulds and cores at the Imperial Steelworks of Edgar Allen & Company was analysed, and the paper described the researches carried out and the deductions derived therefrom.

The problem of drying moulds and cores presented difficulties, especially as the time in which the operation must be completed was strictly limited. At the Imperial Steelworks the time available was from 5 p.m. to 8 a.m., a period of 15 hours. When the author first became acquainted with these works, some sixteen or seventeen years ago, the mould drying was carried out by loading the moulds on to a large carriage or bogie, which was drawn into a brick chamber, provided with fire-boxes at the end farthest from the door, and constructed to burn coke. The process was very unsatisfactory, large quantities of coke being consumed, some of the moulds were spoilt by overheating, others were insufficiently dried and had to be returned, and a proportion only were in a suitable condition to permit of casting. He had reason to think that, even to-day, this method is still in use in some foundries in this country. To illustrate the wasteful use of fuel in a furnace of this design, he pointed out that a drying stove of only 710 cub. ft. contents required 17 cwts. of coke per 14 hours.

Gas Firing of Mould Stoves.

In 1911 it was decided to rebuild the foundry, and, after careful search for better methods of drying, it was decided to instal a number of drying chambers operated by Sheffield town's gas, which at that time was both very cheap and of very good quality. The reasons for this decision were (1) that the whole of the available space could be used for the drying chamber, no room being required for the furnace proper; (2) the construction could be simplified, and, therefore, cheapened; (3) no chimneys were necessary; (4) at the time the price of gas was 10d. per 1,000 cub. ft. for gas of about 560 B.Th.U., and by the elimination of all carting, both of fuel and ashes, and the possibility of reducing the number of attendant operators, it was considered that the use of gas would effect a reduction in costs. This proved to be the case, but the war broke out shortly after the new foundry commenced working, and, arising out of this, the price of gas advanced, whilst the quality receded. Further, the gas company reduced the pressure to an extent that made it impossible to keep the burners alight, and booster fans were installed to raise the pressure. However, little could be done to deal with the extraordinary increase in costs until after the conclusion of the war, when the whole question was carefully investigated.

Whilst the war was in progress no opportunity presented itself for other considerations, but those of increasing output, and, therefore, although it was realised that gas-fired drying stoves left something to be desired, they performed their work, and, compared with the old coke-fired furnaces, possessed undoubted advantages, amongst them being the fact that the minimum amount of labour sufficed for working.

But when the industrial slump arrived it was imperative that all items of expenditure should be strictly investigated, and, amongst others, the drying problem received close attention. As an instance of the increased costs, the author said that in 1915 they had consumed 76,615,590 cub. ft. of gas for drying, for which they had paid £3,939, whilst in 1920, for 53,619,900 cub. ft., they paid £9,691, a decrease of 22,995,600 cub. ft. in consumption, but an increase of £5,562 in the price paid.

In the first place, the drying chambers were plain rectangular constructions varying in size, the standard size being 25 ft. x 11 ft. 6 in. x 7 ft. 6 in. high. The gas burners were of standard bunsen type arranged along the back in most instances, three chambers only being fitted with burners down each side, thermostatic valves in every case being installed, but they proved to be quite valueless.

Research was made to ascertain as exactly as possible the existing conditions and working procedure, and inquiries were directed to the working temperature. Considerable diversity of opinion existed as to the actual temperature attained in the stoves and the temperature necessary to effect drying. No thermometers had been fitted, and the foreman in charge employed the device of spitting on the outside of the doors to judge the degree of heat, presumably by the speed of evaporation. One of Negretti and Zambra's recording thermometers was then fitted, and in the meanwhile a separate gas meter was attached to a standard stove, together with a gas regulator, so as to be able to maintain a constant gas pressure at any desired water gauge within the limits of the main pressure, which was found to be a variable quantity. The thermometer showed that the method of working was a very wasteful one, the graph being practically a uniformly rising line from atmospheric temperature to a maximum of 385 deg. C., at which point (a matter of sixteen hours) the gas was shut off and the moulds withdrawn. This was a somewhat extravagant use of heat. A further point noticed was that, in spite of the very high temperature attained, 385 deg. C., quite a number of the moulds were insufficiently dried, whilst others were burnt. Careful observation showed that the underdried moulds were always on the bottom layer of the carriage, and particularly so at the door end.

A portable recording thermometer was put into service, with the result that the inside of the stove was found to have a decided temperature gradient varying from 385 deg. C. at the roof to 100 deg. C. at the top of the carriage or floor line of the stoves. The logic of this was to average these conditions as much as possible, more especially as, in loading the carriage, large moulds, which required more drying, were placed at the bottom, and small moulds at the top.

Whilst these experiments were in progress an investigation was carried out in the research laboratory to determine the temperature at which the natural bond of the sand would be broken down, and also the limit of temperature advisable when drying an oil sand core: the results showed very clearly the importance of drying at a lower temperature than hitherto in use. Consequently, further endeavours were made to reduce the temperature gradient.

The conclusions arrived at as a consequence of the observations made of the stoves fitted with bunsen burners were:—(1) The nature of the flame, either a true bunsen flame or any other form of non- or semi-luminous flame, made no appreciable difference either to the gas consumption or the temperature attained; (2) the gas pressure was found to be an important factor in the consumption, a slight increase of pressure recording an increased consumption of gas entirely out of proportion to the slight increase in temperature; therefore, steps were taken to regulate the pressure, which was done by putting into circuit a Bryan Donkin Regulator; (3) any difference between burners arranged either at one end or down two sides of a stove was so slight as to be incapable of evaluation; (4) repeated experiments demonstrated that, whatever the temperature of the stove, a thermometer buried in a core or mould registered no more than 100 deg. C.; (5) considerable condensation took place within the stove itself, causing rust on the moulding

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boxes, nails, heads, chills, etc.; this effect was traced to the high hydrogen content of the gas: (6) *Insulation*.—As an experiment, one of the stoves was insulated by a lining of Moler Bricks, which effected a saving of 2,000 ft. of gas per run of 15 hours, and reduced the time required to attain a drying heat; eventually all the stoves were so treated. The author considered this most important, and deserving of close attention whenever furnaces were to be designed.

From the economic point of view, the result of all this was to effect the following saving per stove whenever put into operation:—(i) 2,250 cub. ft. per run by regulation of gas pressure and temperature; (ii) 2,000 cub. ft. per run by insulation, a combined total of 4,250 cub. ft. per run, reducing the consumption from 25,250 to 21,000 cub. ft.

This, although a great improvement, was not considered sufficiently good, and the attack was carried forward on the lines of improving the temperature gradient.

The Fuller Burner System.

About this time the Company's attention was directed to a gas-fired file-hardening furnace invented by a Sheffield man named Fuller, and it was considered that the burner, which possessed special features, could be adapted to their purpose. In collaboration with Mr. Fuller, the experiment was made. The apparatus was very simple, consisting essentially of a gas and air mixing chamber of special design, Keith-Blackman air-pressure fan working at 8in. water gauge, and two 4 in. steel tubes arranged down each side of the drying chamber, and provided with outlets to point towards the central line of the chamber. In working, gas was passed through the mixing chamber and ignited, the secondary air then being turned on, the effect being to project a flame down the entire length of pipe, some 20 ft. Next to the mixing chamber a short fireclay sleeve was inserted in the pipe as a protection, the flame at this point being very intense. This installation was started up in June, 1922, and had since operated six days a week, the gas consumption averaging 1,000 cub. ft. per hour. Compared with the bunsen burners, the results had been very satisfactory; the operating time had been reduced by one hour, and the gas consumption by over 5,000 cub. ft. per run. The cost of working the fan was one shilling, and nothing had been expended in repairs, except a small sum for renewing the fan impeller. The installation had the very great advantage of materially reducing the temperature gradient within the drying chamber and lowering the maximum roof temperature from 385 deg. C. to 225 deg. C.

British Furnace Company's System.

A further pressure-gas installation was tried, made by British Furnaces, Limited. This was very similar to the Fuller system, the essential difference being that a higher air-pressure was employed, and that a much higher temperature was attained at the point of combustion: the results were very similar. In spite of the considerable success attained with these installations, however, they hesitated to proceed further, because it was realised that hydrogen gas was not altogether a suitable fuel for the purpose. Considerable condensation was taking place within the drying stove at all temperatures up to boiling point, and this was considered to be an adverse factor from the moulder's point of view.

Drying Crucibles.

With regard to the drying of clay crucible pots used for the production of special alloy steels, the conventional way (to employ a coke furnace and to construct the drying chamber over the flue from the furnace to chimney) was wasteful in fuel, and had the further disadvantage of creating a considerable temperature gradient in the drying chamber. It also resulted in a large percentage of wasters. Other methods were, therefore, considered, and eventually a high pressure hot water or Perkin's system was installed, with complete success; the coke consumption was halved, wasters were practically eliminated, and so successful did the installation prove that a drying stove for cores was fitted up in the foundry. This, however, was a qualified success only, for at that time they went in extensively for oil-sand cores; the system was unable to cope with cores of this nature, and had to be abandoned. The reasons were that the temperature possible in the drying stove was not in excess of 110 deg. C., and that it was necessary that oil-sand cores should be stoved at a temperature of not less than 180 deg. C., in order that the volatile constituents of the oil be driven off. The stove was quite successful, however, in drying plain sand cores.

As a consequence of this experiment and the close observations made of the gas-fired drying stoves, it was recognised that the ideal stove would be one in which the drying medium would be hot gases, or air in as dry a state as possible, and, if possible of attainment, the temperature should be constant. It was also noted that ventilation of the drying chamber was a most important factor, and, unless intelligently managed, would cause very considerable trouble and loss. It was a costly matter, however, to heat up large quantities of air, and, although it was desirable that hot air should be employed, this line of investigation was reluctantly abandoned.

The Huttenes Stove.

About this time a coke-fired furnace for mould drying was introduced to the notice of the Company by Mr. Arthur Ryner. The claims made for this furnace were remarkable, and the author proceeded to Germany to make inquiries and to see the furnace in operation. As a result, a furnace was ordered, and, after considerable delay, arrived in Sheffield. This furnace, which was patented throughout the world by Messrs. Huttenes & Oehm, of Dusseldorf, was applied in Germany to drying large moulds *in situ*, the *modus operandi* being to close the mould temporarily, instal the furnace above, and pass the hot products of combustion into the cavity of the mould, vents being provided. The furnace itself was simply a steel-plate box, lined with firebricks, divided into a combustion chamber, with firebars and feeding door at top; the fuel used was low-grade coke, breeze, lignite, or any other cheap fuel. The hot gases passed over a bridge at one end of the furnace, down each side of vanes or louvres of firebrick, between which they were met by a compressed air jet at 80 lbs. pressure per sq. in. The effect of this was to increase materially the draught through the firebars, and, what was even more important, project the products of combustion into the drying chamber at a high velocity.

Immediately the furnace arrived at Sheffield it was tried upon a large mould just completed in the foundry floor, with the unfortunate result of burning it—in fact, spoiling it completely. This was somewhat negative, but after all it did show that very considerable temperatures were attained, and gave rise to the suggestion that the furnace should be attached to one of the drying chambers. This was carried out at once, and a trial run made, with most satisfactory results. Considerable progress had since been made in the adaptation of the furnace to the requirements of mould and core drying in chambers; the use of the apparatus as a portable appliance for drying moulds *in situ* will receive attention later.

As a sequel to their experimental work with the furnace, they had constructed a brick furnace which, for convenience of operation, was in most cases sunk into the ground. The essential features of the compressed-air jet, firebrick louvres, etc., were retained, but the direction of the hot gases was reversed from a downward to an upward direction. A further development was to operate a number of drying chambers from one furnace only, which was achieved by the employment of as many compressed-air jets as drying chambers. They also pre-heated the compressed-air considerably. These arrangements had proved very economical, which, no doubt, said the author, was to be accounted for, amongst other reasons, by the fact that thermal losses in the furnace were decreased proportionately to the number of drying chambers served. A further interesting feature was the possibility of carrying the hot gases considerable distances at high velocity and with little loss of heat; the farthest point to which they have at present carried the gases from the furnace to the drying chambers is 32 ft.

Advantages of the Huttenes System.

The advantages attributed to this type of furnace, used for the purpose described, were enumerated as follows:—

(1) The fuel consumption is economical; (2) it requires little attention during the run; (3) within the limits of the apparatus the temperature may be readily regulated without difficulty by turning on more or less air; (4) it takes up very little space and is quite cheap to build and maintain; (5) it does not require chimney; (6) it can, if necessary, be placed at some distance from the drying chamber with little loss of thermal units; (7) one furnace may be used to serve a number of drying chambers, thereby reducing labour at the furnace and cheapening the construction; (8) a satisfactory thermographical chart may be closely copied, thus providing an invaluable guide to the operator; (9) the cheapest available fuel above the grade of dust may be used—the company are using cinders obtained from the Corporation cleansing department collected with the household refuse; (10) whenever compressed air is in use, it provides a useful night load and so reduces overhead charges on this item of plant; (11) the air consumption is low and the charges therefor small; (12) the hot gases may, with facility, be conducted to any part of the drying chamber and, together with the ventilation, dispositions may be made to produce either an equable temperature throughout the chamber or any desired temperature gradient within the capacity of the installation; (13) complete combustion is attained; only slight traces of CO have been shown wherever analyses were taken; (14) the drying chambers are under pressure with considerable circulation currents in the hot gas; and (15) ordinary unskilled labour may be employed to operate the installation, a thermograph chart being a record of all that takes place during a run, and at the same time a guide to the operator.

The data obtained from careful observations of the performance of these furnaces for the past 10 months, said the author, although not complete, were sufficient to substantiate the claims made, and his paper gave the information obtained from those observations.

The furnace on which the tests were made was arranged at one end of a large drying-chamber for moulds. The drying-chamber was 24 ft. 6 in. long, 11 ft. wide, and 8 ft. high, with a capacity of 2,156 cub. ft. The moulds were conveyed into the chamber by means of a travelling carriage, which was sealed by a sand trough, the floor of the carriage being constructed of iron plates insulated by asbestos millboard. The walls of the drying chamber were 14 in. thick in red brickwork, and the roof construction was of steel joists, between which were sprung small jack-arches of two half brick rings, the outside of the roof being covered with "Moler" insulation bricks. The door was balanced and made to lift vertically and constructed of steel plates, between which asbestos was sandwiched.

The furnace proper, which was quite small, was situated at the end opposite the door, was constructed of 4½ in. best quality firebrick surrounded by "Moler" insulating bricks, the outside being 4½ in. red brickwork. The furnace was sunk into the ground, the top being at ground level.

The products of combustion were carried into the drying stove by a brick flue, and inside the stove carried forward and equally distributed by a 10 in. cast-iron perforated pipe, supported on and situated down the longitudinal axis of the carriage in such a way as to register with the brick flue from the furnace. This device was quite simple and effective, and was adopted as a standard, but in some instances the distributing pipe was carried either down one side or across one end of the drying chamber, as found most convenient, it being understood that in every case the lay-out was designed to suit existing arrangements.

The moulds, in their cast-iron boxes, were piled up on the carriage, small spaces being arranged around, above and below each box, to permit the hot gases to circulate. No particular order was observed in packing, but generally speaking, for convenience of handling, the large boxes were placed at the bottom and the small boxes at the top of the pile. Every endeavour was made to place as many moulds as possible upon the carriage. An average load would be 30 to 35 tons, including cast-iron boxes and sand.

All the moulds were thoroughly dried at the end of the run, and no moulds were found to be burnt or imperfectly dried. As in some cases the thickness of rammed sand to be dried was up to 15 in., contained in a cast-iron box ⅜ in. to 1 in. thick, a period of 15 hours for drying might be considered rapid.

The grate area of the furnace was 7 sq. ft., the firebars being of cast iron, of similar design to those in common use in a Lancashire boiler. The outlet flue conveying the hot gases into the drying chamber was 10 in. dia., the compressed-air jet being 3/16 in. dia., and the air pressure 80 lbs. In lighting the furnace a bed of coke was placed upon the bars, a few shovelsful of burning coke or cinders placed on top, and the air turned partially on. In about 20 minutes the furnace was well alight, the air was then turned on fully, the furnace fed from time to time with fresh fuel, and the firebars kept clean. The time-temperature chart showed clearly the time in which these operations were performed during a run.

The average working temperature employed for mould drying was 225 deg. C., for large cores 200 deg. C., and for small cores 180 deg. C. The fuel burnt was as follows:—Mould drying stoves, 7 cwts. of coke; large core ovens, 4½ cwts. of 15 hours; and small core ovens, 4 cwts. all for a run of 15 hours.

The author was unable to give the air consumption in terms of cub. ft. per minute, but tests were taken of the electrical units consumed. The air was supplied by the foundry air compressor plant, consisting of two Belliss and Morcom high-speed two-stage compressors, electrically driven, of 150 cub. ft. free air capacity. They were fitted with electrical meters. During a period of six hours operating one furnace only, the electrical energy consumed was 52 units. The air service being extensive, and the stove under test at the end of the pipe being farthest from the compressor, it was necessary to make a correction for leaks and other loss of efficiency. Therefore, a further run of six hours was made with all air-using units cut out of service, and 30 electrical units were expended. Deducting this amount from the gross total previously given, 22 was the net amount of current consumed in a run of six hours, or at the rate of 3.6 per hour, the net cost for current only being 1s. 7½d. per run of six hours. A further test was made with five jets in operation, and the consumption was 189 units. Making the same deduction, viz., 30 units, the net amount of current consumed in a run of six hours, using five jets, was 159 units, or an average of 32 per jet per six hours.

The average fuel consumption per hour for one month was 32 lbs., 56 lbs., 36 lbs., and 36 lbs. for four different furnaces.

The following are the results of a test on No. 2 furnace on August 18 last, burning coke breeze:—

Average temperature in drying chamber 190 deg. C., in the centre of the chamber at a point 6 in. from the underside of the roof; practically the same reading was obtained at the end next the furnace at a point midway between the carriage floor and the underside of the roof. A further reading was taken on top of the carriage next to the outer door which gave an average of 150 deg. C. The temperature of the products of combustion at a point between the louvres and immediately inside the drying chamber ranged from 920 deg. C. to 740 deg. C. over a period of two hours. Air pressure was shown by previous experiments to be the most efficient. The ventilation outlets were set to give a total of 48 sq. ins. area, also determined by previous experiment. This, of course, was in addition to leakages through door jambs, etc.

Samples of the products of combustion were taken both when just leaving the furnace and after admixture with the compressed air and analysed, the samples being drawn off simultaneously, the temperature in the flue pipe being 920 deg. C. The results of the analysis were:—Before admixture with compressed air: CO_2, 13.15; O_2, nil, and CO, 12.85 per cent. After admixture with compressed air, the analysis showed: CO_2, 13.96; O_2, 5.23, and CO, 0.41 per cent.

Heat Treatment of Carbon-Steel Castings.

The American Society for Testing Materials, in conjunction with the American Foundrymen's Association, has published a *Tentative Standard* for the purpose of eliciting criticism and suggestions. It is not a Standard of the Society, and is subject to annual revision.

(1) This recommended practice is intended solely for guidance, and is not to be construed as entering in any manner into specifications of the American Society for Testing Materials.

(2) This recommended practice is intended to cover (*a*) annealing, (*b*) normalising, (*c*) normalising followed by reheating, and (*d*) quenching followed by reheating.

(3) After pouring, the castings should be allowed to cool in the sand to a temperature below the critical range.

(4) The castings should be sufficiently cleaned of adhering sand before heat treatment to ensure thorough and uniform heating.

(5) The temperatures recommended when treatment above the upper critical point is desired should vary with the carbon content, approximately as follows:—Up to 0.40 per cent. carbon, inclusive, 900 deg. C.; over 0.40 to 0.60 per cent., inclusive, 850 deg. C.; and over 0.60 per cent., 830 deg. C.

(6) The use of pyrometers (preferably recording pyrometers) is recommended. Pyrometers should be checked frequently against a standard. Every precaution should be taken to procure due assurance that the castings throughout the furnace reach the required temperature.

(7) After cooling is indicated in Section 3, the castings should then be heated slowly and uniformly to the desired temperature. Sufficient time should be allowed for the heat to accomplish the desired structural transformations throughout the mass of the castings. For these reasons it is necessary that each furnace containing castings be held for a prolonged period at the desired temperature after the castings have attained that temperature. It is recommended that this prolonged period should be not less than 60 minutes for each inch of thickness of the thickest casting segment in the charge.

(8) To anneal castings properly they should be heated as described in Section 7 to one of the temperatures given in Section 5. They should then be slowly cooled in the furnace until they reach a faint red colour, after which the cooling may be continued in air.

(9) To secure finer structure (with probably less ductility than can be obtained by annealing as described in Section 8) castings should be heated as described in Section 7 to one of the temperatures given in Section 5, and cooled in still air.

(10) To secure fine structure, accompanied by great ductility, normalising as described in Section 9 should be followed by a reheating and subsequent cooling. In this reheating, the castings may be kept for a short time just above the lower critical point or they may be kept for several hours at a suitable temperature below the critical range. After this reheating, the castings should be cooled slowly in the furnace until they reach a faint red colour (provided they reach this colour in the reheating), after which the cooling may be continued in air.

(11) To secure maximum refinement of the structure coupled with the greatest possible combination of strength and toughness, castings should be heated as described in Section 7 to one of the temperatures given in Section 5, and quenched in water or oil. They should then be reheated. In this reheating, the castings may be kept for a short time just above the lower critical point, or they may be kept for several hours at a suitable temperature below the critical range. After this reheating the castings should be cooled slowly in the furnace until they reach a faint red colour (provided that colour was reached in the reheating operation), after which the cooling may be continued in air.

(12) (*a*) Certain castings which from their mass or design would crack on quenching if kept in the water or oil until completely cold may be safely treated by removing them from the quenching bath when they have reached a black heat, immediately charging them into a furnace heated to approximately the same temperature as the castings, and reheating them as described in Section 11. (*b*) The advisability of attempting to quench and reheat any given casting must be considered with judgment in the light of experience, and to attempt to apply this method of heat treatment without taking the precautions demanded by the shape, size, and sections of each individual casting can only result in the loss of many castings through the development of cracks either in quenching, in reheating, or at some later time.

Notes on Gas Supply to Open-Hearth Furnaces.

By Ivon A. Bailey.

The importance of a supply of consistently good quality gas, at a constant pressure, to an open-hearth steel plant is not always fully appreciated. The cause of many defects in finished steel products can be directly traced to an unreliable and poor quality of gas supply to the furnaces.

Steel that has been made under conditions where there is difficulty in easily maintaining sufficient heat may be detrimentally affected in many ways. Steel that has been worked and tapped on the cold side is "dirty," and is probably not thoroughly de-oxidised. Again, a charge that has been "pigged" and "stewed" in the furnace for many hours in order to gain a tapping temperature is not likely to give good results as a finished product, although the analysis may be satisfactory, since dissolved oxides and gases are practically certain to be present in excess of normal quantities. This is due to the fact that the reactions in the furnace during "refining" have not taken place under equilibrium conditions, and a condition of chemical instability exists, which is seldom overcome entirely.

The ideal method of working a normal charge is to melt hot, but when melted, to maintain only a moderate heat until the charge is nearly ready (in analysis) for tapping, and then to bring the heat up to a tapping temperature in an hour or so, thus subjecting the brickwork to the maximum heat for a relatively short period only. If a furnaceman is confident that a constant pressure of good-quality gas is always available, he will find no difficulty in gathering heat at will without injuring the furnace structure.

With a modern gas installation and a reasonably good coal it is possible to maintain a supply of gas containing 42 to 45 per cent. combustibles, and by installing also an efficient gas-pressure regulator, such as the "Arca," to maintain also a gas pressure of, say, 1½ in. w.g. in the main. With a reliable supply of this type of gas good outputs should be, and are being obtained with a minimum amount of wear on the furnaces.

A satisfactory analysis of gas for open-hearth work is as follows in percentages:—CO_2, 4 to 6; CO, 24 to 26; H_2, 15 (maximum); CH_4, 3 to 4; total combustibles, 42 to 45 per cent. This quality of gas is being constantly obtained by several gas installations, working on different quality coals, some of which could hardly be described as first-class gas coals. The advantages described above, together with a large reduction in labour costs, make a gas installation a necessity to an open-hearth plant capable of a high rate of production.

Specifications for Grey Iron.

The British Cast Iron Research Association is co-operating with the Institute of British Foundrymen and the British Engineering Standards Association in the preparation of national specifications for grey iron castings. Specimens of existing specifications for grey iron, issued by private firms, consulting engineers and others are desired, and readers are invited to send copies of specifications on loan, or copies thereof, to the Director, at Central House, New Street, Birmingham.

The Metallurgy of Aluminium.—IV.

By F. A. Livermore.

ALLOYS.

It is well known that pure aluminium is entirely unsuited for many engineering purposes; both in the cast and worked condition it is too soft to produce satisfactory castings which are required to bear or resist heavy stresses. In order, then, to overcome this, it is the universal practice to stiffen up the metal with some hardening element or elements depending on the physical and mechanical properties required. Accordingly the aim of the metallurgist has been to discover alloys possessing toughness and the desired strength: this opens out a vista for much controversy and metallurgist research. Pure aluminium in the cast condition has a tensile strength of only 5 tons per sq. in., but a high elongation of 30 to 40 per cent on 2 in. A higher tensile figure and increase of hardness is obtained by the addition of alloying metals, but this is almost invariably at the expense of its ductility and lightness, and where such castings are subjected to shock it is not advisable to increase the hardening effect beyond a certain point. Aluminium combines readily with most of the metals, the union being generally accompanied with the expulsion of heat, which is very active in the case of copper. This gives rise to the theory that such alloys are chemical combinations of the metals rather than mere mechanical mixtures. Of recent years microphotography has endorsed this, and it is definitely known that chemical re-action does take place.

Mercury, antimony and lead are the only metals which present great difficulty in alloying. Of course the primary feature that made aluminium so attractive from the engineering point of view, was its lightness, and from the founders point of view, its low melting point, so it is necessary in considering the characteristics of alloys to set forth a practical compromise between the antagonistic requirements of low-melting point, high tensile strength and ductility at ordinary temperation and temperature below the point of solidification. Now with the exception of special alloys—those containing magnesium—all the alloys compounded with the common metal are heavier than the pure metal, and less ductile. With the common metals used for the alloying with aluminium the tensile strength rises very rapidly as the percentages of the hardeners are increased, but beyond a certain point the increase is small while brittleness increases until it reaches the other end of the series when the properties again become valuable. Therefore, beyond a certain point the increase in strength is not in proportion to the increase in weight, and comparing the two—strength and weight—it is more profitable to keep within narrow limits, and so the use of hardeners is seen to be attended with well recognised objections. Thus the advisability of alloying over using the pure metal depends upon the improvements brought about in the mechanical properties by the addition of the hardeners. The microstructure of pure aluminium in the cast state consists of an aggregate of a large number of crystals, and shows a typical structure of a pure metal. Under stress these crystals are deformed and tend to break asunder, so in order to make the possibility of this deformation more acute, that is, to strengthen or stiffen up the metal, another element or elements, generally a metal which remains in the solid material uniformly disseminated throughout the crystals, is added and functions as a stimulator to the crystal of the pure metal. Certain metals, however, are not uniformly disseminated throughout the metal, and the microstructure reveals these constituents in the interstices and around the boundaries of the simple crystals. Although often this second constituent tends to strengthen the alloy, the introduction is accompanied by a reduction in ductility, should the addition of the second constituent be overdone, ultimately the ductility lowers to practically zero and the alloy becomes brittle. With an alloy of 94 per cent. of aluminium and 6 per cent. of copper, an elongation of 10 per cent on 2 in., and a maximum stress of 9.6 tons per sq. in. is attained. After rolling, the tensile strength reaches 17 tons per sq. in. and the elongation increases to 21 per cent. The following are results of tensile tests made from samples taken at random from heats; the alloy contained 1.5 per cent. manganese, 2 per cent. copper, the remainder being aluminium:—

Per cent. elongation on 2 in.	*Max. stress tons per sq. in.*
14.0	9.8
12.0	9.8
13.5	9.7
14.0	9.5
14.7	9.5

The following results were obtained from samples from the same alloys after being drop forged:—

Per cent. elongation on 2 in.	*Max. stress tons per sq. in.*
21.95	15.6
19.9	15.0
21.0	15.0

From these sets of figures it can clearly be seen that the mechanical properties have been materially improved upon over the pure aluminium. The mechanical properties of an alloy of 88 per cent. aluminium and 12 per cent. copper show the maximum stress stands at 9.7 tons per sq. in., but the elongation attains only 1.5 per cent. on 2 in. It can readily be deduced that the 6 per cent. alloy exhibits advantages over the 12 per cent. alloy in respect to weight and elongation. In fact, as the percentage of copper increases, so a hard, brittle aluminium-copper compound (Al_2Cu) forms, and is distributed in large connected masses throughout the metal; it is advisable to keep the copper content low, in order to limit as much as possible the brittle eutectic.

Fig. 5 represents the microsection of an alloy with 16 per cent. copper and the rest aluminium in the chill-cast state—etched in dilute nitric acid;

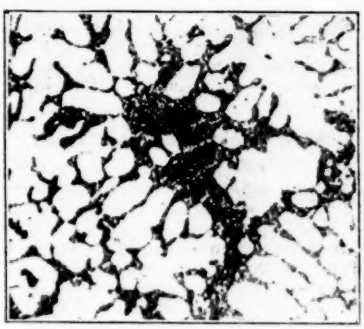


FIG. 5.

in this alloy as the $CuAl_2$ compound predominates, and it is possible to detect only the most meagre traces of any other constituents than the solid solution.

Fig. 6 shows an alloy of 12 per cent copper etched as before, sand-cast: the Al_2Cu compound is seen associated with the needle-shaped constituents.

The use of manganese in relatively small quantities hardens and strengthens the alloy without destroying its ductility, but unfortunately reduces its thermal conductivity, the machining properties are excellent, and when properly moulded the most intricate castings can be produced free from hot shortness with comparative ease.

4Cu : 96Al.

Condition.	Yield point. Tons per sq. in.	Max stress. Tons per sq. in.	Elongation per cent. on 2 in.
Sand cast ..	4.9	6.5	5.5
Chill ,, ..	5.4	9.6	10.5

If it is not desired further to harden the alloy, the manganese should be used in place of part of

the copper; thus in a 4 per cent. copper alloy, 1 per cent. of copper may be replaced by 1 per cent. of manganese, giving an alloy containing 3 per cent. of copper, 1 per cent. of manganese, and the remainder of aluminium. The mechanical properties of the alloy are:—

Cu. : 1 Mn. : 96Al.

Condition.	Yield point. Tons per sq. in.	Max stress. Tons per sq. in.	Elongation per cent. on 2 in.
Sand cast ..	6.0	7.5	5.0
Chill ,, ..	7.3	12.1	13.0

Here the chill castings in particular show an appreciable advantage in respect to tensile strength; it is also known that the addition of a small amount of manganese aids the alloy in resisting corrosion, with this advantage in mind; small percentages of manganese, between 0.1 per cent. and 0.5 per cent., are added to alloys used in

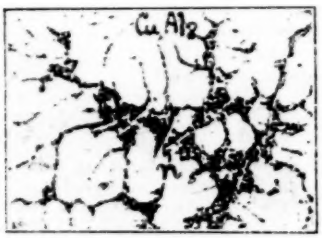


FIG. 6.

the casting of kitchen utensils and similar materials where resistance to corrosion is of greater importance than tensile strength; these additions greatly facilitate casting.

In this section the subject will be limited to the more common aluminium alloys, and will not include the many "freak" aluminium alloys, by which is meant uncommon alloys which have not yet proved of real worth to the engineering world. Practically all the standard aluminium alloys can be successfully cast. The two main classes of aluminium casting alloys are (1) those containing copper as the principal hardening medium, with or without the addition of small percentages of other elements; (2) those containing zinc as the principal hardening medium, either with or without the addition of small percentages of other elements.

Alloys of Aluminium and Copper.

This class is specially favoured by the French and American foundries. Small percentages of copper hardens aluminium without affecting its malleability. Alloys containing up to 6 per cent. of copper possess good machining and casting properties; when the copper content exceeds 10 per cent., however, the malleability decreases proportionately and brittleness sets in, due to the formation of the brittle copper-aluminium (Cu_2Al) eutectic. The brothers Cowles produced an alloy of 16.8 per cent. of copper whose tensile strength was 13.0 tons per sq. in. and density 3.23, but since the elongation was practically nil, it proved useless for practice.

TABLE V.—*Tensile Properties of Aluminium-Copper Alloys.*

Alloy.	Condition.	Yield point. Tons per sq. in.	Max. stress. Tons per sq. in.	Elongation per cent. on 2 in
97Al.: 3Cu ..	Sand cast	6.0	8.5	5.5
	Chill ,,	6.5	11.0	12.5
96Al.: 4Cu..	Sand ,,	5.0	7.6	5.0
	Chill ,,	5.7	9.8	11.5
95Al.: 5Cu..	Sand ,,	4.9	7.5	5.4
	Chill ,,	5.4	9.6	10.5

Alloys containing from 30 to 40 per cent. of copper are very brittle, as hard as glass, and have a beautiful crystalline structure. The 50 per cent. alloy is somewhat soft, but as the copper content rises to 70 per cent., the alloys pass through transitory stages of glass hardness to comparative softness, but still retains the perceptible brittleness; so it will be realised that alloys with between about 15 to 70 per cent. of copper hardeners are useless for the production of castings for engineering and automobile work. Personally, the author favours alloys containing 3 to 5 per cent. of copper and the remainder aluminium, as they present very little difficulty in casting, and display excellent mechanical properties in the cast state. Table V gives the physical properties of three alloys.

The properties of most copper alloys are considerably increased by heat treatment. The object of the heat treatment or annealing is to bring into solid solution as much as possible of the aluminium-copper compound which in the ordinary cast condition is present in the alloy as a separate constituent. Dr. Rosenhain, in a lecture before the Royal Society of Arts, stated that in the case of an ordinary chill-cast test piece annealing was extended over a period of three days at a temperature from 450 deg. to 520 deg. C. The result of the treatment was an increase in tensile strength of the alloy from 10 tons per sq. in. to 14.5 tons per sq. in., whilst the elongation on 2 in. was increased from 10 to 21 per cent. This is no doubt an improvement and discovery worthy of note, but unfortunately it would be difficult to apply it to practice, since the annealing period is so prolonged. Manganese, like copper or zinc, in small quantities hardens and strengthens the alloy without destroying its ductility. An alloy of 96 per cent. aluminium, 3 per cent. copper, 1 per cent. manganese, gives admirable results, and possesses all the desirable properties cited for casting, such as low specific gravity; strength and freedom from brittleness; machines well; maximum resistance to corrosion; and good casting qualities and freedom from hot-shortness.

This alloy is recommended as suitable for all classes of aluminium casting, and even for that of die casting.

Alloys of Aluminium and Zinc.

This class is specially favoured by the British foundries. Their constitution and properties have been very extensively studied by the Alloys Committee; the alloys which are of any practical importance, so far as light materials are concerned, are those containing less than 30 per cent. of zinc when brought into solution, and into a condition of complete equilibrium; all these alloys show the typical structure of solution which closely resembles that of a pure metal.

This is shown in Fig. 7, and represents an alloy of 15 per cent. of zinc after rolling and annealing.

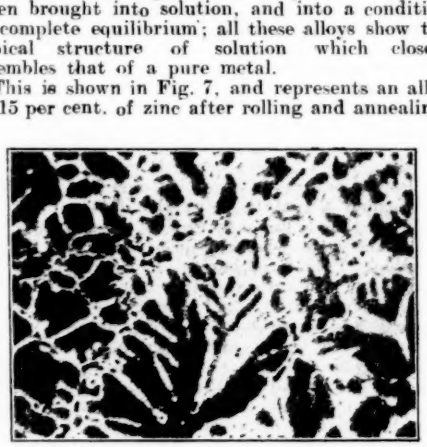


FIG. 7.

Aluminium unites readily with zinc to form an alloy much harder and more fusible than the pure metal. Debray says an alloy of 3 per cent. zinc considerably hardens the metal without destroying its malleability, and when cast into sand moulds gives the surface of the casting a very brilliant crystalline or etched appearance. Brittleness begins to show itself when the zinc content exceeds 20 per cent.; the alloys around this composition are invariably brittle, their fracture showing a white crystalline structure. Aluminium-zinc alloys have the reputation of being particularly subject to fatigue; this is due to the weakening effect of certain impurities of commercial spelter. Lead in particular is very deleterious to any aluminium alloy, and when castings of the zinc base alloy are required to pass stringent physical tests, only high grade zinc should be used. Other dangerous impurities are carbon, silicon and iron, and the greatest precaution should be taken to prevent the introduction of this foreign matter.

either in the metal used or through the medium of crucible and tools. While the mechanical properties of the aluminium-zinc alloys are themselves remarkable, they are not without incidental disadvantages. Zinc-rich alloys are very soft and fragile when hot, and readily cracks as a result of shrinkage and careless handling; also castings cannot be made of less than a specified thickness which is necessary to ensure the metal flowing and also to give the casting sufficient robustness for handling in the machine shop, etc. The 15 per cent. zinc and rest aluminium alloy is in common use, and gives every satisfaction.

Advantage, however, can be taken of the fact that the addition of 2 to 3 per cent. of copper is attended by an increase in tensile strength of 3 to 4 tons per sq. in. as shown in the following table:—

Alloy (Sand cast).	Yield point. Tons per sq. in.	Max. stress. Tons per sq. in.	Elongation per cent. on 2 in.
A185, Zn15 ..	9,5	11.0	2.2
A182, Zn15, Cu3	9.8	14.0	3.0

The copper in the alloy helps to eliminate the porous nature of the binary aluminium-zinc alloy castings; it greatly increases the tensile strength, has a stimulating action on the fluidity of the metal, and does not sensibly affect either the specific gravity or the price. The aluminium-zinc-copper alloy, which is now fairly universally adopted, contains 2 to 3 per cent. of copper, 10 to 15 per cent. of zinc and aluminium as the balance. It is noteworthy that alloys of aluminium containing both zinc and copper are peculiarly liable to corrosion. If exposed to the air in the ordinary way they will retain this surface indefinitely, but if exposed to the action of sea water they corrode and rapidly deteriorate: this peculiarity must be borne in mind when adapting them to commercial use. However, protection from this corrosion can be effected by a covering of varnish or bituminous paint, but often it is not found expedient to avail ourselves of this means of surmounting the difficulty, and accordingly much research has been done to discover new alloys which will answer the purpose and yet retain the characteristic properties of the other alloys. The best alloy has a composition of 4 per cent. of copper, 2 per cent. of nickel, 1½ per cent. of magnesium, and the remainder aluminium. The addition of nickel offers a point of interest; usually the addition of a new element renders the alloy hard and very difficult to roll or work, but precisely the opposite happens. While the alloy without the nickel cannot be successfully rolled, with it, it can be rolled and worked with considerable ease; this is supposed to be due to the formation of a ternary copper aluminium and nickel alloy, which is not so brittle as aluminium copper (Cu_2Al) formation.

Of late years engineers have realised the great benefits gained from the use of aluminium alloys for pistons in internal combustion engines owing to its high thermal conductivity and light weight in comparison with iron and steel. The copper-aluminium alloys with varying percentage of copper from 10 to 12 per cent. should have answered the purpose, but owing to migration of the copper-aluminium eutectic (CuAl) at high temperatures, failure resulted. However, the introduction of 1 per cent. of manganese maintained the strength of the alloy at high temperatures, and very satisfactory pistons were produced; it is unfortunate that the manganese slightly reduces the thermal conductivity and so partially destroys the benefit gained, since the piston works at a higher temperature, but this deviation is quite small and has no decided evil effect upon the efficiency of this alloy at the temperature to which pistons are exposed in service. An alloy of 4 per cent. of copper, 2 per cent. of tin, 1.5 per cent. of zinc and the remainder aluminium is recommended as a good alloy for piston use; very good results have been recorded with this alloy.

The zinc series of alloys are of no use whatever for pistons or engine parts which are subjected to heat round about their critical temperatures, or to shocks; they fail on account of their inability to withstand severe alternating stresses when hot and their low melting-points.

Duralumin is an alloy of:—Copper, 3.5; aluminium, 94.5; silicon, 0.5; iron, 0.6; and manganese, 0.4 per cent., and has proved of considerable worth for constructional purposes. The properties required for the construction of rigid girders for airship and aeroplane are the maximum combination of strength and lightness; it might be recalled that most of the all-metal type were built up of this material.

Foundry Queries.

Defective Nickel Castings.

(August 28.)

The following should help "T. W. A." to overcome porous metal or blowholes appearing on the surface of pure nickel castings.

Nickel calls for great attention during the melting process; it requires a hot and rapid melting furnace, such as the forced draught type. If the ordinary natural draught furnace is used the period of melting is longer; therefore, oxidation and gas absorption is greater, resulting in porous metal caused by the expulsion of these gases near or on the point of solidification.

With such type of furnace better results are obtained if small amounts are melted at a charge. Porosity is also caused by using sand containing too much bond, hard-rammed sand, sand too wet or containing too much moisture. If these castings are cast in green sand a good open sand should be used, and the surface of the mould should be dusted with French chalk.

When melting pure commercial nickel cover fluxes and deoxidants should be used to keep down oxidation as far as is practicable. The following will prove serviceable:—Three parts lime and one part fluor-spar, or lime alone; also salt (NaCl), glass, borax, etc.

From experience the best deoxidant is magnesium (Mg); good results can also be derived from aluminium (Al) or manganese (Mn).

Whatever deoxidant is preferred, it is necessary to add small amounts at first until the desired results are attained. One ounce to 100 lbs. of pure nickel of any of the above-mentioned metals will be sufficient.

When adding magnesium care should be taken to keep it well under the metal, using a pair of tongs previously warmed to prevent accidents.—G. C. SWIFT.

The Suggested Combine in the Iron and Steel Trades.

Sir William Larke, the Director of the National Federation of Iron and Steel Manufacturers, in the course of an interview with the press, is stated to have made interesting comment on the proposals that the British iron and steel industry should organise itself on national lines, particularly in connection with the development of overseas trade, and possibly also in the direction of purchasing essential raw materials. The scheme was briefly mentioned in our last issue.

Sir William Larke pointed out that these recommendations, which appear to have the support of representative Labour leaders, were actually made by the important Committee appointed by the Board of Trade to consider the position of the iron and steel trades after the war. This Committee submitted a report, dated June 13, 1917, in which the following recommendations appeared:—

> That iron and steel manufacturers should associate themselves for the purpose of export trade, and should form selling organisations by the extension and consolidation of associations which already exist.
>
> That an organisation, co-operative in character, be formed among British manfacturers for the purpose of obtaining adequate supplies of suitable iron ore.

Thus the ideas incorporated in these recommendations have been before the industry for some considerable time.

These matters, continued Sir William Larke, are engaging continuously the serious consideration of the leaders of the industry, and the result of such consideration will doubtless in due time be placed before the Government Committee on Industry and Trade, of which Sir Arthur Balfour, of Sheffield, is chairman, together with evidence on the present position, and in support of any recommendations that the leaders of the industry find themselves in a position to make.

The Analysis of Grey Iron Foundry Alloys.—VI.

By H. H. S.

The Gravimetric Estimation of Sulphur.

The method to be described may appear new to many chemists, due, no doubt, to the fact that it does not enjoy the popularity accorded to the Aqua Regia process; but the method is of many years' standing, and for the writer's first association with it he is indebted to the late Mr. Macfarlane, at one time principal of Wednesbury Technical School. The method is easy, clean, and rapid to manipulate; further, the accuracy obtainable is undoubtedly high. When one considers the difficulty of extracting 0.005 grammes of sulphur (=0.10 per cent.) from nearly 5 grammes of iron without the resulting precipitate being contaminated with iron, one will appreciate the extent of the advantage of being able to remove that iron at an early stage in the estimation: this is done by oxidising the iron and separating from it the sulphur by the aid of treatment of the residue with sodium-carbonate solution.

Solutions Required.

The following solutions are required:—Concentrated HNO_3 and HCl: 1 per cent. solution of anhydrous Na_2CO_3: a 50 and a 2 per cent. solution of HCl and a 10 per cent. solution of barium chloride ($BaCl_2$).

The Estimation.

Weigh into a 4-in. dia. porcelain evaporating dish—"S.C.P. Japan" or Worcester porcelain is very satisfactory—5 grs. of the properly prepared sample, cover with a 5-in. cover glass, and add carefully 35 c.c.s. of concentrated HNO_3, place on the edge of the hot plate until the action becomes violent: here a little extra care is required, or the liquid will soon froth over the basin top. Remove from the plate to a warm place near a second unheated plate—next to the hot plate is convenient—it is usually warm enough to allow the action to proceed gently. When the dissolving action is complete, shown by the absence of brown fumes, add to the dish 2 grs. of potassium nitrate (KNO_3), and gently evaporate to dryness, and then heat for 1½ hrs. on the hottest part of the plate. Remove the cover glass, and place the dish in the front end of the muffle, which should be at a good red heat (850 to 900 deg. C.), heat in this position for 10 mins., then push the dish to the back end and heat for a further 10 mins. The writer recommends actual timing of these periods.

After heating for 20 mins., as described, remove and place the dish on the top of the muffle to cool a little; this prevents cracking. Now place on an asbestos pad, cover with the cover glass again; when sufficiently cool to withstand without cracking the addition of liquid, add 75 c.c. of a 1.0 per cent. solution of anhydrous Na_2CO_3; place the dish over a bunsen burner and on an asbestos-centred gauze, heat to boiling; boil for about 3 mins. Detach the iron oxide from the sides and bottom of the dish by the aid of a glass rod, and at the same time break up as small as possible the pieces of oxide; this should be done while the liquid is boiling. The releasing of the oxide often causes violent bumping, which necessitates constant attention of this operation: well made and correctly shaped dishes and covers will, however, prevent any loss of solution. After releasing and breaking up the oxide, boil for a further 2 mins., then remove from the burner.

The handling of the dish while on the hot plate, in the muffle, and on the burner is conveniently done by means of a stout iron wire holder, shown in Fig. 10, made up to the shape and measurements indicated, from ⅛-in. dia. wire. When most of the iron oxide has settled out, decant off the liquid through a 15 c.m. Whatman No. 40 or Munktell I.F. filter paper. The filtrate usually contains some iron oxide which is in a fine state of division, and on the first filtration passes through the filter, it is therefore advisable at this stage to re-filter the filtrate, allowing it to pass into a 400 c.c. squat form beaker. Throughout the whole operation of filtering and washing the iron oxide residue, *ordinary distilled water must not be used, washing is carried out by the use of a hot* 1.0 *per cent. solution of* Na_2CO_3: if water alone is used the iron oxide will constantly pass through the filter paper, and cause endless trouble. After decanting and refiltering, the sides and bottom of the dish are well cleaned with the aid of a "bobby" and a jet of 1.0 per cent. Na_2CO_3, from a wash bottle. Make two decantations, then wash all the residue into the filter; wash three or four times with the hot soda solution. Acidify the filtrate by adding 15 c.c. of HCl (1 to 1): test with litmus to ensure that the solution is acid: the method of washing and amount of HCl stated will, in most practices, give the correct acidity, *i.e.*, the avoidance of a large excess of HCl. Cover the beaker with a 3½- or 4-in. clock glass and evaporate to dryness, taking precaution to avoid "spitting" of the solution when it is nearing dryness, as at this stage the crystallising out of chlorides and sulphates takes place rather suddenly. A safe plan is to place a piece of asbestos board on the hot plate previously, then, when the liquid shows signs of "spitting," remove the beaker on to the asbestos, and it will go down to dryness fairly quietly. When the residue is quite dry, shown by it being white, remove the beaker, allow it to cool, add 5 c.c.s. of concentrated HCl and 50 c.c. H_2O; boil gently for about 5 mins., or until all the salts are taken into solution. Filter off the silica, using a Whatman's 12.5 c.m. No. 40 paper. Wash the paper about three times with hot 2 per cent. HCl and twice with hot water: the volume should now measure about 150 c.c. or less; heat to boiling, and whilst stirring pour slowly into the solution 10 c.c.s. of 10 per cent. $BaCl_2$ solution. Now boil gently for 15 mins., and for very accurate work allow to stand overnight. If the estimation is required by this method in routine work, 2 hrs. standing will ensure an accuracy well within the limits of works practice requirements.

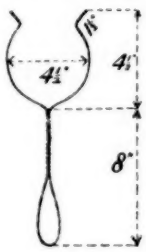


FIG. 10.

When the solution is ready for filtering, decant off as much as possible of the clear liquid through a 12.5 cm. No. 40 paper, add to the beaker about 20 c.c. of hot 2 per cent. HCl, allow the precipitate to settle for a minute or two, decant again, after having washed the paper once with the acid in the meantime. When the precipitate has settled, again pour off the clear liquid, and allow this to pass through the paper completely before washing the precipitate from the beaker into the filter by the aid of a hot-water jet, clean the sides of the beaker of any adhering precipitate, passing all washings through the filter. The writer finds that, with "quick-settling" precipitates, decanting cuts down the number of washings and time required.

Wash once with 2 per cent. HCl and once with water; repeat this, then wash four or five times with H_2O (hot), taking care to avoid driving the precipitate over the top of the paper, by first washing the top edge of the filter paper and gradually working down inside to the apex. Remove the beaker containing fibrate, wash the funnel stem, then place beneath it a beaker containing a few c.c. of water and about 5 c.c. of $Ag\ NO_3$ (that used in the "persulphate manganese method" is suitable), wash the filter once: if no chloride is indicated, the paper is removed carefully from the funnel, folded as described for "silicon," and (for most accurate work) placed into a *weighed* porcelain crucible, dry the paper, and then allow to smoulder to ash in front of the muffle. If the filter and precipitate are placed in the muffle so that the paper flames, it sometimes causes the often still damp precipitate to absorb some of the

carbon, which is very difficult to burn out. When the paper has smouldered to ash, place the crucible in the muffle and heat at good red heat for 20 minutes; remove, allow to cool in a desiccater, and re-weigh (or, for less accurate work, brush out the $BaSO_4$ on to a counterpoised scoop), and the difference in weight (or weight of the $BaSO_4$) equals the S present in the iron, the acids, and the Na_2CO_3, and there may be—especially if new dishes were used—a little from this source, when the whole will be expressed as $BaSO_4$. The weight of $BaSO_4$ found on a blank estimation, using same reagents, etc., is deducted from the total weight of $BaSO_4$ found; the difference × 13.73 ÷ 5 equals the percentage of sulphur.

The late Mr. Macfarlane recommended the use of platinum basins, but that was in the days when that metal was comparatively cheap, and many laboratories founded within the last few years, and which often require to make many special sulphur determinations, would find themselves faced with a very heavy, and to a large extent unnecessary, bill if they purchased platinum dishes sufficient in number to meet their apparent requirements. A good quality porcelain will meet these requirements almost equally as well, only that a little more care is required when conducting the blank estimation. In the first place, a new *set of dishes* ample to meet likely needs should be put into use together, and if a new dish is at any time put into service alongside "old" dishes, it should be treated in the following manner before making an actual sulphur determination in it. The writer has found that treatment of reagents only in a new dish to ascertain the blank is very likely to give a false result, the blank being usually higher than is actually the case, because the dish is attacked in the evaporating and baking operations. The blank is therefore obtained by a "difference" method, treatment being identical with the treatment of sample. A standard pig-iron containing a known amount of sulphur, such as issued by the British Chemical Standards Association, is used, or if one is fortunate to possess a platinum dish, one can make a sulphur standard by carrying out an estimation on a properly sampled pig, and also determine the blank (applicable only to that particular estimation). A suitable standard may be procured by drilling sections of a 42 in. × 2 in. × 1 in. test bar which has been well machined all over and is quite clean and sound in fracture. Two or three duplicate analyses are made on drillings taken from different positions in the bar; if the results agree, then the drillings may be mixed and the bar kept as the source for sulphur standards. When one has once mastered the little details and general practice of the gravimetric method described, its many advantages will at once be appreciated to the extent of scrapping the use of the Aqua Regia method.

The writer has, over considerable periods, had checks conducted by two of the most reputable firms of referee analysts in the country, and the greatest difference between the results of the referees and those of the writer has ben 0.003 per cent., while many agreed to within 0.001 per cent., so that the accuracy of the method given is sufficient for *all* purposes.

Studies in the Aluminium-Zinc System.*

By Tomojiro Tanabe.

Summary.

Previous investigations into the constitution of the alloys of aluminium and zinc have been very numerous, but work hitherto published has been almost entirely limited to thermal analysis and microscopic examination, and the results of tests in other directions, notably in the physical, are very few.

Accordingly, the present writer has investigated this system in various directions, to confirm the new diagram of Hanson and Gayler, and to make clear the nature of age-hardening. The mechanical properties have also been studied.

* A Paper presented at the Annual Autumn Meeting of the Institute of Metals.

The Determination of Sulphur in Cast Iron.

By "A."

The writer has read with much interest the extremely useful series of articles by "H. H. S." on the "Analysis of Grey Iron." He submits an alternative method for the estimation of sulphur, which takes about 30 minutes, and has been proved to be very reliable.

Reagents Required.

Zn.-Cd.—Acetate Solution.—20 grs. of zinc acetate and 5 grs. of cadmium acetate are dissolved in a mixture of 80 c.c. water and 20 c.c. acetic acid.

A Solution of $CuSO_4$.—To 800 c.c. water are added 125 c.c. H_2SO_4, and in it are dissolved 125 c.c. of $CuSO_4$.

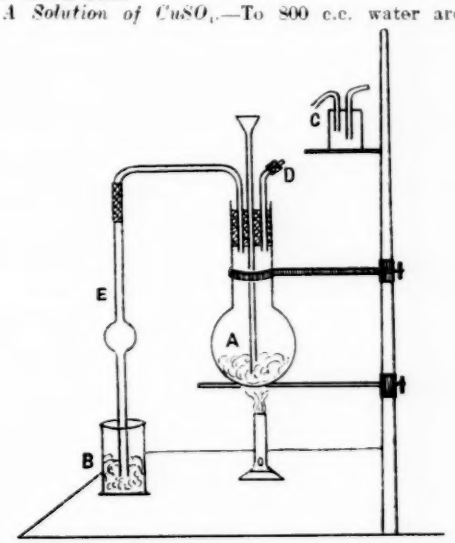


FIG. 1.

The apparatus is quite simple, and could be made up of an ordinary wash bottle and a separation funnel as shown in Fig. 1.

Procedure.

10 grs. of fine drillings are weighed out and transferred into the flask *A*. The absorption glass *B* is filled up to about one-third its height with 40 c.c. zinc-cadmium acetate solution.

After the apparatus has been connected and proved to be airtight, 50 c.c. of H_2O are poured in through the funnel into the flask, and then 150 c.c. HCL (dil. 1:1) are added, slowly heated, and the H_2S is passed over into the glass *B* and absorbed by the Cd.-Zn solution.

When all the sulphur has been practically driven off, the rest of the sulphur which may be still in the flask and tube is expelled by a pressure of air by means of a boiling wash bottle. The wash bottle *C* is then connected with tube *D*, and whilst the wash bottle is kept boiling, the air which passes into the apparatus expels the sulphur.

The tube *E* is then disconnected and the sulphide is washed off into the absorption glass.

To the solution are now added 5 c.c. of the $CuSO_4$ solution; it is well shaken, and the precipitate can be filtered almost immediately. After thoroughly washing with hot water, the precipitate is slowly dried, gradually heated and strongly ignited under cover in the muffle until all is converted to CuO. The factor to be used is 0.4041.

Standardising District Foundry Costs.

Mr. J. L. Carter, addressing a joint meeting of eastern American district foundrymen's associations, said that in the Newark district progress had been made by the adoption of a uniform costing system. The majority of the foundries had joined a co-operative scheme for keeping standard costs. This was accomplished by employing an expert to control the cost accounting of all foundries in the group. It is now proposed to extend the system to take in other districts

"Stainless Steel" and "Ceylon Plumbago."

A conference of engineering societies, organised by the Society of Engineers, was held at the British Empire Exhibition, Wembley, last week. There were present a number of delegates from many societies associated with the engineering industry, including the Institute of British Foundrymen, and a number of Papers were read and discussed. Mr. A. S. Buckle (Senior Vice-President of the Society of Engineers) presided.

"THE WORKING OF STAINLESS STEEL."

In a Paper on this subject, MISS C. GRIFF (Chairman of the Women's Engineering Society, and Founder and Managing Director of the Stainless and Non-Corrosive Metal Company, Birmingham) dealt with the commercial aspect of the use and working of this metal, and gave her personal experiences in connection with it. Owing to cutlery being the only use to which stainless steel was put for some considerable time, said the author, the impression was given that it was too hard for any other purpose. Brearley (discoverer of the metal, and a director of Brown Bayley Steelworks) had, however, gone far beyond this, and was developing brands which were soft enough to machine. It was, perhaps, not always easily machineable, but much blame had been, and still is, put on to stainless steel that should fall on the operator and his tool. For example, the author remembered seeing a large iron casting defy numerous high-speed tool steels to remove its skin expeditiously, until the foreman was persuaded to try a special high-speed 18 per cent. tungsten tool steel; this had proved to be satisfactory, and a good cut was taken without trouble. Had this casting been of stainless steel, it would doubtless have been condemned as impossible to machine.

Although apparently a simple thing to make, the tin-openers made by a company with which the writer was connected had given them experience in nearly every process of working stainless steels. After various trials, it was decided to use the "Immaculate" brand for the ¼-in. sq. top portion, cutting it for the full lengths for the tang, and milling the required taper, until someone suggested forging this out to save material. This was tried, but it then required too much heat-treatment to get it back to as good a condition for working as it was in previous to forging. Therefore, it had proved more economical to use more steel than to forge the tangs from short lengths. Provided high-speed drills and cutters were used, no trouble had been experienced in milling and drilling the ¼-in. sq. rod in the condition in which it was received from the mills.

The working of stainless-steel sheet was chiefly a matter of common sense. It was first tried for trays and weighing-machine pans, which necessitated beaded edges. At the time 24 S.W.G. was the thinnest sheet that was rolled as a commercial proposition, but Vickers had specially rolled some down to 28 S.W.G. for the author's company. With this they had stamped and beaded the edges as if it had been tin, without any sign of cracking at the bend. Having accomplished this, they were up against the worst trouble experienced, namely, the removal of scale and the bottoming of the pits in polishing, and they had found that to use cold-rolled sheets was the only satisfactory method. The commercial aspect had to be considered, but they had found that in 75 cases out of 100 it was cheaper to pay the extra cost for cold-rolled sheet, for, besides lessening the costly process of polishing, it eliminated—so far as their experience went—the risk of subsequent corrosion. Pickling could sometimes be substituted for cold rolling; it was much less costly, approximately only 1d. per lb. extra on the black hot-rolled sheet prices.

Another question which most manufacturers had to decide was the comparative advantage of stainless "iron" and steel. The difference between the two qualities was small, the former containing less than 0.1 per cent. carbon, one brand having only 0.07 per cent., whereas the stainless steels proper varied from 0.1 per cent. to 0.5 per cent. carbon. The author could again provide an effective object lesson on this question of choice of material. Some strip sufficiently soft to press easily, yet which could be hardened to withstand anything in reason, and to retain a good cutting edge, was required. They first tried some good stainless iron, and, though they obtained a good cutting edge, it did not retain it sufficiently, and the whole blade bent too easily. They then tried mild stainless steel, which was quite satisfactory, except that, not being cold rolled or pickled, the polishing was too costly. Then, hearing of a new pickled finish, they ordered some strip in a soft steel quality, but the makers, knowing it was for press work, insisted that their brand of stainless iron would be the best; against their better judgment, the author's firm had used it, but had had to case-harden the blades. This appeared at the time to be satisfactory, but eventually trouble from corrosion developed, and the blades were too easily bent. This seemed to show that the addition of carbon by the case-hardening process destroyed the rustless properties of the steel entirely. They were now using a well-pickled stainless steel of between 0.1 and 0.2 per cent. carbon, which was satisfactory to press and yet hardened well without brittleness.

Stainless Castings.

As to the casting of stainless steel, the author was not at liberty to describe in detail any of the work with which she was connected; all that could be said was that the castings were being produced which were reasonably good, remembering that ordinary steel castings were not always perfection. The heat treatment of these castings was a difficult business, and they were getting some peculiar results from their experiments, of which the following is an example:—The Brinell hardness before annealing was 460. After raising to 1,000 deg. C., soaking for two hours, and cooling in a furnace, the hardness No. was 460. After second treatment as above, the hardness No. was 460. After raising to 650 deg. C., soaking for one hour, and cooling in furnace, the hardness No. was 415.

The author made an appeal to users of stainless steel castings not to condemn them as being too hard to machine until they had given them a chance by grinding a small surface free of skin to give the tool a good starting-off place. This sounded a foolishly obvious piece of advice, but she had saved perfectly good stainless-steel castings from the scrap heap by this practice.

Summing up, she said that stainless steel could be worked well as a commercial proposition, but care and thought must be given to (1) the quality and brand of the steel for each particular job; (2) the method of handling and the tools used; (3) the overhead charges, which must be kept low, to equalise the costs of material and labour. Roughly, her company reckoned to allow 15 to 25 per cent. more for labour on stainless steel than they would do for the working of mild steel.

"CEYLON PLUMBAGO."

The mining, uses and high qualities of Ceylon plumbago were dealt with in a Paper by MR. T. G. HUNTER, the Paper being read at the request of the Commissioners of the Ceylon Pavilion at Wembley. The output of crystalline plumbago from Ceylon, which is the only British possession in which it is obtained, was also dealt with. The average annual export of plumbago from Ceylon for the years 1909 to 1919 was 24,404 tons, the export value for all grades being £23 per ton at Colombo, the port of shipment. A maximum of 668,216 cwts. was exported in 1916, and during 1916 and 1917 as much as £100 per ton at Colombo was realised for some of the best grades of lumps. The latest returns showed that 213,383 cwts. were exported during 1923. The industry has been subjected to periodic depressions and inflations, the most prosperous periods coinciding with war times. The present is probably the worst depression it has ever had to experience.

After a description of the mining of plumbago, the reduction of impurities, and its preparation for the market, the author said that the characteristics possessed by plumbago made it a mineral of great industrial importance, its purity and physical character determining its industrial application. The purity of plumbago could be

tested by analysis for carbon and the containing impurities, but the physical properties could not be so easily determined by accepted rules, and skill and long experience was necessary in order to be able to judge these.

Some of the uses for which plumbago was essential were the making of crucibles, lubricants, polishing, pencils, foundry facings, and for electrical purposes.

Crucible Manufacture.

Discussing one of its oldest and most important applications, namely, in the manufacture of crucibles for the iron, steel, brass and bronze industries, the author said that the facts that plumbago was nearly pure carbon, was relatively inert chemically, and volatilised only at very high temperatures made it of value for this purpose. Such crucibles must have good tensile strength, and the poorer the binding quality of the plumbago used the larger the quantity of less refractory binding material which must be added to bind the mass together, thus increasing the more fusible constituents of the crucible at the expense of the more refractory, and materially decreasing its life. For this reason a fibrous or flaky plumbago was used, for the inter-locking of these flakes or fibres added to the tensile strength, and Ceylon plumbago was claimed to be undoubtedly the very best material for this purpose. Until comparatively recent years Ceylon plumbago was considered to be essential for the making of a good crucible, and it might still be correct to say that the best crucibles could be made entirely with Ceylon plumbago, though crucibles are now being made with a material containing proportions of other than Ceylon plumbago. It might be seriously questioned, however, whether any good crucibles were being made entirely without Ceylon plumbago, and it was probable that the higher the percentage of the Ceylon product used in the mixture, the more efficient the crucible produced. This was certainly found to be the case in the U.S.A., where they had made experiments to try to introduce their flake graphite into crucible making, but it was considered inadvisable to go beyond 10 per cent. of this material, as anything more seriously affected the efficiency of the crucible. The Ceylon variety was more cubical in form, and carried a greater surface area in proportion to its volume. Other varieties gathered and held air, and did not resist pressure to the same extent, nor were they so easy to press into a form without an excessive amount of binder. The crucible maker aimed to use the minimum amount of clay possible, because of its slow conductivity and readiness to absorb moisture, thus increasing the tendency to crack under the expansion and contraction conditions to which the crucibles were exposed in service. It has been stated in America, which was Ceylon's largest purchaser, that in order to maintain the standard of efficiency in the plumbago crucible it would be necessary to use the Ceylon product, whatever tariff might be imposed on it. It was claimed that Ceylon plumbago was superior to all others for crucible making, and the same might be said for the manufacture of other refractory products, such as muffles, stirring rods, dipping cups, skimmers and nozzles, as these were usually made from materials similar to those used for crucibles.

Foundry Facings.

Among the other uses for plumbago was the manufacture of foundry facings. It was essential that the facing should stick to the face of the mould, so as to prevent the molten metal from touching it. For this purpose Ceylon plumbago was most suitable on account of its physical structure. The chief claim for it was that it possessed a larger covering surface than any other plumbago, and facings made with it stuck to the face of the mould. Other varieties, owing to their light, fluffy, flaky structure, would not stick, and when the iron was poured into the mould it picked up the light, thin flakes, and the flow of the iron washed the plumbago off the face of the mould, the iron touched the sand, which was fused and burned fast to the iron, and the casting was either spoiled or required hours of cleaning.

The Ceylon plumbago industry has been for some time, and is still in a depressed condition, owing to lack of demand, and production is at a very low ebb. Should the conditions again become favourable, said the author, it was estimated that Ceylon would be able to produce something like 30,000 tons annually for a good many years to come. The main factors responsible for the present depressed condition were the general economic condition of the world; the use of electric furnaces for smelting; the increased efficiency of the crucibles now manufactured, making them capable of standing more heats than formerly, and thus reducing the quantity of plumbago required (the latter two reasons were said to apply more in the U.S.A. than in the United Kingdom); competition with the plumbago from other countries, more especially Madagascar, the large stocks of both the raw material and the manufactured articles that were on hand at the end of the war, and which had to be absorbed. Such plumbago had been sold at prices below that at which a margin of profit could be obtained by present-day mining. The author pointed out that, though the Ceylon stocks were not yet exhausted, there was reason to believe that Madagascar had reached the stage at which they would have to depend on freshly mined product. They would probably not be able to place this on the market at the same low price that had ruled for some time, and thus would not be in a position to under-quote the Ceylon product to any great extent.

In conclusion, the author said that some of the Ceylon firms were endeavouring to grind and refine their plumbago in Ceylon with the hope that such a product might be found to meet the requirements of the trade.

Discussion.

DR. C. A. HEWAVITARNE (Commissioner for Ceylon, Ceylon Pavilion, Wembley, said that at one time Ceylon produced 30,000 tons of plumbago annually, and that was used very largely in England. But the position had changed. Since 1913 deposits had been found in Madagascar, and the Ceylon product had been undercut in price. The Ceylon plumbago was an Imperial asset, and it looked as though we were going to lose it very shortly, because unless England helped Ceylon it might be found that within the next three or four years the plumbago industry might disappear from Ceylon, and thus from the British Empire. If we let the product go out of our hands it would be a serious matter, especially in times of war.

MR. S. OXTON JONES attributed the ability of Madagascar to undercut Ceylon to the fact that the value of the franc was low. If it were back to its normal position, he said the price of Madagascar plumbago would be 200 per cent. above that of the Ceylon product.

MR. S. G. MARTLEW also urged manufacturers to use Empire products in preference to others.

Standardisation of Pipe Flanges and Fittings.

Rapid and important progress is being made by the Sectional Committee on Pipe Flanges and Fittings, working under the procedure of the American Engineering Standards Committee. One of the more important changes is the elimination of approximately half of the sizes above 10 in. in diameter; the older size series provided an unnecessarily close spacing of diameters. A rather remarkable piece of work has been done in the preparation of standards for steel flanges and flanged fittings, for 250, 400, 600 and 900 lb. steam pressure, with 750 deg. Fah. superheat temperature.

Extensive work on pipe and pipe fittings accomplished during the last four or five years in Germany, Switzerland and Holland, by the national standardising bodies working in close co-operation, has now reached a tentative conclusion. Germany, Switzerland and Holland have under consideration well-advanced drafts of standards for pipe flanges and fittings that are in very close agreement. It is likely that Western and Central Europe will adopt a comprehensive international system of pipe and pipe flange standards, including all kinds of metallic pipe, and the fittings used with all types of such pipe, together with standard sizes and forms of gaskets and other accessory items.—"The Iron Age."

Making Propellers.—I.

By Ben Shaw and James Edgar.

The title "Making Propellers" for these articles has been chosen because their object will be to explain clearly and as simply as possible the patternmaking and moulding practice usually adopted in British foundries. Let it be plainly stated that no claim is made that all the methods to be described, especially in regard to details, are the best possible, but they will be found to be practicable, and they are given as the result of practical experience in several of the important marine centres. Design is not so much the concern of the foundryman as the draughtsman, but some knowledge of the fundamental principles on which propeller-design is based is almost necessary and is undoubtedly of value. There is no more absorbing study than the screw propeller, and no work in the foundry that is of greater interest. To foundrymen in inland centres who have not had the experience, the making of a pattern, of sweeps, or a mould seem infinitely difficult, but, in reality, the difficulties are not greater than in other departments of foundry practice.

Historical.

The screw propeller has been defined as an instrument for the propulsion of a vessel, consisting of two or more oblique blades set on a shaft or shafts lying nearly parallel with the keel and revolving beneath the water at the stern. The Chinese were probably the first users of propellers. One writer traces the evolution of this method of vessel propulsion from the earliest form, which was the use of the hand, by one of our Stone Age ancestors as he lay on a floating log. After a lapse of time, says the writer—which was probably of considerable length—flat pieces of wood were substituted as more efficient paddles. The oscillating movement of a single oar, as in "sculling," whereby the blade moves obliquely, somewhat as the blades of a screw propeller do, may possibly have led to the idea of the screw propeller in much the same way as the reciprocating action in straight paddling became substituted by the continuous motion of the floats on a paddle vessel.

The screw propeller, as it now exists, is essentially modern, and does not go back further than the middle of the 18th century. An attempt to adapt the archimedean screw was tried by Pancton in 1768, and consisted of a revolving cylinder of some length with the thread of a screw round it. In 1784 a considerable advance was made by Joseph Bramah, a London engineer, who invented a wheel furnished with inclined fans or wings. This was attached to a shaft which entered the ship's stern and was made to revolve from inside the ship. About the end of the 18th century a perpetual-sculling machine was invented, which consisted of a stern screw, and which was operated by a hand-worked capstan. The introduction of the steamship at the beginning of the 19th century caused a rapid succession of propellers to be invented. Hessel, an Austrian, invented one type in 1826, but it was not until 1836 that the helical or screw propeller was successfully introduced by Smith and Erricson. A few years previously, however, Wilson, a Manchester engineer, was awarded a silver medal by the Scottish Society of Arts for a propeller invention.

The principle of the propeller does not differ materially from the principle of a worm or spiral wheel. It might almost be described as a multiple-threaded worm, sections of the helix of each thread being brought to the same plane and spaced equally around a comparatively small cylinder. The principle is simply that of a screw of an abnormally coarse pitch. The propeller screws its way through the water, and therefore pushes the vessel that is ahead of it. For the propulsion of aeroplanes the screw is called a "tractor," because it is at the front, and draws the machine after it. In a certain work on propeller design the statement is made that "the propulsion effect of an oar, a paddle, or a screw is due to the reaction from a mass of water projected in a direction opposite to that in which it is intended the vessel shall move." "The kick of a gun or rifle produced by the reaction of the projectile is analogous," says the same writer, "to the push obtained from the reaction of each particle of water directed aft. Indeed, a boat might be driven forward by a continuous discharge of firearms, or even by someone aboard throwing objects astern." All this is rather misleading, and might well make the patternmaker and the moulder wonder why so much accuracy is demanded of them. It is much better to regard the propeller as a screw which goes through the water in the same way as a wood screw penetrates wood, except that in the former case the action is not as positive, and propeller designers have to consider the quantity of work that is lost by slip, eddy making, and several other factors which need not be gone into in detail here. It is important, however, that the foundryman should understand that the action of a screw propeller is akin to that of a scull used over the stern of a boat, and different in principle from the action of the paddle.

Types of Propellers.

Readers who have a knowledge of gearing will find it easy to understand the definitions which must be thoroughly understood before the geometry of the subject, the patternmaking and the moulding, can be described. Propellers may have either broad-tipped or leaf-shaped blades. Until about 20 years ago all propellers had leaf-shaped blades, but this type is now largely confined to merchant vessels. It was found in practice that the broad-tipped type of propeller gave the best results when the speed of the vessel was the important factor. There is greater difficulty in moulding a broad-bladed propeller because the trailing edge of one blade may actually be underneath the leading edge of the next blade. This may necessitate cutting away part of the loam mould—undercutting—and it may not be possible to get a straight vertical lift of the cope.

In passing, it may be of interest to state that square-shouldered blades have been almost abandoned altogether, because they produced vibration, while for screws with a large area a broad-tipped outline is frequently adopted to reduce cavitation at the tips, where there is the greatest rotational velocity. It is well for the foundryman to know that the question of the number of blades is largely a matter of expediency, and has no all-important bearing on the efficiency of the screw. A three-bladed propeller has a slightly higher efficiency than a four-bladed one. On the other hand, the four-bladed propeller is frequently preferred for merchant vessels, because if a blade is knocked off—a not uncommon accident—there is more uniform stress on the shafting and bearing than when a three-bladed propeller loses a blade. This means that a vessel which has a propeller accident a considerable distance from port can carry on better when the propeller is four-bladed. With regard to the boss, the smaller it is in diameter the less resistance is offered to the progress of the screw. The diameter varies from one-fourth to one-sixth the propeller diameter, and sometimes less, while its length is between two and two-and-a-half times the diameter of the tail shaft.

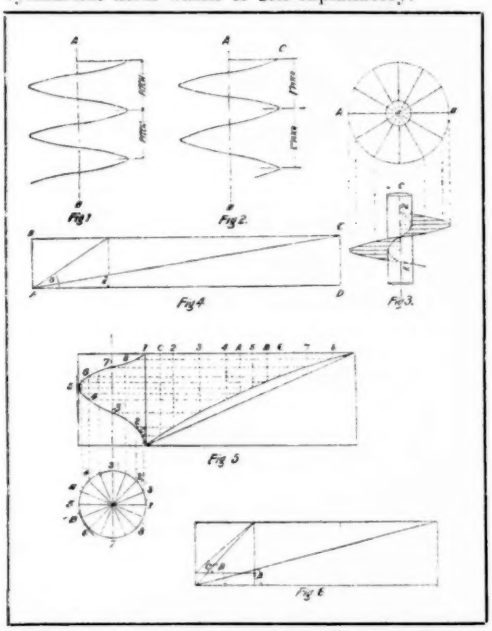
Technical Terms Explained.

The diameter of a propeller is the diameter described by the blade tips of the screw in its rotation. This circle is sometimes called the disc circle, and its area the disc area of the screw. The pitch of a propeller, or the pitch of any screw, is the distance a point moving along its helical path would advance in the direction of the axis of the screw in one revolution, or, it may be expressed more clearly, by stating that the pitch represents the distance the vessel would advance from one revolution of the propeller if there were no slip. The question of slip is, of course, for the designer to consider, and it is no concern of the foundryman. The developed area is the sum of the areas of the working surfaces of all the blades exclusive of the hub or boss, while the developed surface of the blade face is the approxi-

mate total surface of the face were it set out as a plane surface. The projected area is the sum of the areas of the blades exclusive of the boss as projected on an athwartship plane, while the projected surface is the area of projection of the face of the blade on an athwartship plane, or plane at right-angles to the axis of the propeller, which is the effective driving surface. The greater the pitch the smaller is the projected surface.

The ratio is the term for the pitch divided by the diameter.

A helix is a screw curve which is formed by a point rotating set a fixed distance from an axis and advancing at a uniform angle. This is not a text-book definition, but it will perhaps make more clear to the practical man what is meant by the term. The distance the point moves parallel to the axis in one revolution is called the pitch. It is a helix of uniform pitch when the rotating point moves parallel to the axis with uniform velocity, but when the velocity is not uniform the curve generated is termed a helix of variable pitch. Fig. 1 illustrates a helix of uniform pitch and Fig. 2 a helix of variable pitch. Fig. 3 shows a geometrical method of generating a cylindrical helix which is self-explanatory.



It is most important that the foundryman should know what is meant by the term "pitch angle." At Fig. 3 the diameter AB represents the diameter of the propeller and the length 1 – 2, Fig. 3 the distance that the rotating point moves in one revolution, or, in other words, the pitch. To obtain the pitch angle it is necessary to develop the periphery of the cylinder with the diameter AB Fig. 3 and length 1 – 2, into a rectangle ABCD (Fig. 4). A diagonal line AC is drawn, and the angle E is the pitch angle. The pitch angle, it must be clearly understood, is different at every diameter of the propeller blade; in other words, the angle at the boss of a propeller of uniform pitch is much greater than the angle at the extreme tips of the blades. Thus the cylinder C Fig. 3 represents the boss of the propeller. To obtain the pitch angle at this diameter a rectangle would be formed of the developed cylinder C, and the required angle would be G, Fig. 4.

Varying Pitch.

The majority of propellers are of uniform pitch, and of the remainder, which have a varying pitch, the pitch may vary axially or radially, or, as in some exceptional instances, they may vary both axially and radially. Here it may be said that when the pitch of a propeller is the same at the boss as at the tips of the blades, it is called a true screw. We shall consider now what is meant by the terms "axially varying pitch" and "radially varying pitch." We have seen that when a point is rotated at a fixed distance from an axis, a helix is formed: if the point instead of moving at a uniform velocity moves at a continually increasing —accelerated—velocity, a curve will be formed which corresponds to the outer periphery of a propeller of axially varying pitch. At all radii from the axis each point moves with a corresponding acceleration. Fig. 5 illustrates a helix of increasing or axially varying pitch. Propellers are sometimes made which from the boss to a certain diameter are of uniform pitch, and from this diameter to the outside diameter the pitch becomes axially varying. In the case of propellers of radially varying pitch, the pitch at the outer diameter of the propeller is invariably greater than the pitch at the boss. Fig. 6 may make this form of varying pitch clear. The angles A and B are respectively the pitch angles at the outer diameter and the boss of a propeller of uniform pitch, but, with a propeller of radially varying pitch, while the angle at the outer diameter would be as A, the angle at the boss would be C. At no two diameters is the pitch of a propeller, in which the pitch varies radially, the same. Propellers are sometimes made which are both axially and radially varying in pitch. This means that if a point is rotated about an axis at a fixed distance corresponding to the diameter of the propeller at an accelerated velocity, and another point is rotated at a fixed distance corresponding to the boss at a lesser degree of acceleration, a surface will be generated which is both axially and radially varying.

While the foregoing is a condensed explanation of the principles and the methods of forming the helices for the variety of screw formations in propellers, and when once fully understood are not easily forgotten, yet we recognise that practical definitions of the different forms are more easily remembered, and think that these can be profitably added in the following manner:—

When a propeller has a similar pitch throughout it is known as a true screw.

When the pitch of the leading edge differs from that of the following edge, the pitch is said to vary axially.

When the pitch of the blade near to the boss differs from that at the tip, then the pitch is said to vary radially.

When the pitch varies not only between the boss and tip, but also between the leading and following edges, then the propeller is said to have both an axially and radially varying pitch.

The leading edge is that edge of the propeller blade which first enters the water when the vessel is being driven ahead. The after edge beyond the centre is termed the trailing or following edge.

The face is the after surface of the blade, which is the geometrically generated surface, and the opposite surface is called the back of the blade.

Propellers are made both left- and right-handed; the analogy of the wood screw will help readers to understand what is meant by this. If a propeller, viewed from the stern of a ship, revolves clockwise, it is a right-handed propeller. In the foundry, if the high side of the drag is at the right hand when looking towards the boss, a right-handed propeller is being made. It is important to remember this when old templates are being looked out by the patternmaker for a repeat order. These complete the definitions which the patternmaker ought to thoroughly understand before he starts to set down a propeller.

Publications Received.

The Story of the A.F.A.—This little propaganda booklet describing the activities of the American Foundrymen's Association will be sent to any British foundryman on application to the Secretary at 140, South Dearborn Street, Chicago.

Propelling a Cargo Boat, by D. B. MORISON, M.I.N.A.—The first sixteen pages of this handsome brochure are devoted to technical data in connection with the propulsion of cargo boats, whilst the balance, some 20 pages, describes and illustrates the manufactures of Westgarth, Richardson & Company, Limited, of Hartlepool, Middlesbrough and Sunderland.

Port of Leith Handbook.—This booklet is the joint production of the Leith Dock Commission and the local Chamber of Commerce. More than 100 pages are devoted to its harbour and docks, and the manufactures, industries and trades of the Port.

Lubrication in the Steel Industry.*

Lubrication is the key to efficiency and production in the steel plant. The intensive operation demanded calls for a minimum of friction and uniformity of bearing temperatures in the face of the most discouraging operating conditions. Hot water, acid fumes, salt, dirt, dust, etc., are examples of the objectionable factors confronting the lubricating engineer. Take a concrete example: Air-compressor and blowing-engine lubrication at best is a ticklish proposition; but a small amount of dirt or a short period of operation on the wrong compressor oil may give rise to dangerous conditions or often fires in the air lines; perhaps even explosions or ruptures will result.

Lubrication of Blast-Furnace Equipment.

Blast-furnace operation involves the use of considerable mechanical apparatus. For example, there are the large steam reciprocating or turbo-blowing engines which furnish the necessary low-pressure air to the hot-blast stoves for pre-heating prior to delivery to the blast furnaces; also the charging equipment, which includes the wire ropes and bearings of the charging lorries and skip hoists, with their respective driving engines or motors, the slag cranes, the steam or hydraulic clay guns, the ladle cars, and any miscellaneous gearing installed.

While the range of equipment is varied, the lubricating problems are not numerous. The blast furnace generates high heats and these are naturally radiated to their surroundings quite considerably. It is perfectly possible, however, to locate much of the necessary mechanical equipment, either permanently or otherwise, so that it will be both free from this heat and also not subject to excessive dirt or dust. Take the case of blower steam cylinders for example: If they are lubricated with a good grade of cylinder oil which has been compounded and refined to meet the requirements of steam and operating conditions, perfect satisfaction should be attained. Bearings in turn can be grouped into two classifications: (1) As involving automatic lubricators, or (2) exposed, hand-oiled conditions.

Steam-engine, pump, turbo-blower, and electric-motor bearings are largely oiled by some automatic system of lubrication. Inasmuch as they are usually enclosed systems and not subjected to external heat, they should give little or no trouble. Exposed, hand-oiled bearings, as are found on skip buckets and transfer cars, etc., receive rougher service, and dust, dirt, and rain are always detrimental factors. Such bearings have high clearances, however, and operate at low speeds and pressures; therefore a rough lubricant such as black oil is found to serve very well.

Gears and wire rope operate under similar conditions to skip-car journal bearings, though at perhaps higher working pressures. Therefore, a lubricant must be used which will not drip from their surfaces, which will penetrate to the core of the ropes, and which will adhere tenaciously to the gear teeth in an even film. Usually a straight mineral gear-and-rope compound of from 1,000 to 2,000 seconds viscosity Saybolt at 210 deg. Fah. will satisfy these requirements.

Air-tub lubrication is exceedingly important, due to the fact that pressure must be kept on the lines to the blast furnaces and Bessemer converters, etc., at all times. Therefore, cleaning is practically impossible, and the blowing-cylinder lubricant must be so refined as to give rise to minimum carbonaceous accumulations in the air system as far as possible. Furthermore, every care should be observed to insure against feeding oil in excessive quantities to the air cylinders. In fact, the right kind of oil will lubricate most satisfactorily when a minimum amount is fed to the cylinders. Excess never improves lubrication and only leads to objectionable oil deposits. Air-tub pressures in the steel plant are usually low (in the neighbourhood of 15 to 20 lbs.), and temperatures will therefore never run much above 300 deg. Fah.

Blast-furnace devices require careful attention to lubrication, for bearing and gear lubricants must withstand heat, pressure, dust and contamination by flying sparks. A straight mineral lubricant of from 1,000 to 5,000 seconds viscosity Saybolt at 210 deg. Fah., according to weather and temperature conditions, has been found best suited for this service. Bearings are usually hand-lubricated with the exception of ring-oiled motor bearings; to meet the rough conditions involved black oil is generally used. Motor bearings, however, require a good grade of medium-viscosity oil.

Bessemer Converters.

The fierce heat adjacent to the Bessemer converter naturally gives rise to considerable scepticism when it comes to lubrication. But the converter has to operate, and be free to swing readily when charging or pouring is done; therefore the operating mechanism, which comprises a pair of hydraulic plungers with suitable racks and pinions adjacent to the trunnions, must work with the least possible friction, otherwise the power consumption and time of turning might be rapidly increased. These gear mechanisms as well as the plungers are subject to very high conducted heat; therefore the lubricant must be heat-resisting to the highest degree. A straight mineral product of high viscosity has been found to meet the converter's requirements satisfactorily, due to its adhesive characteristics.

The blast for the blowing of Bessemer converters may be supplied by either horizontal or vertical steam blowers or turbo-blowers. These normally are located in engine rooms apart from the converters, and their lubrication, involving circulating oiling systems or mechanical force-feed lubricators, is similar to that of any power-plant unit, with no serious problems to worry about.

From the converters the steel is poured into a ladle which is usually carried by a crane capable of swinging on a vertical axis, for transfer to the ingot moulds. Cranes of this type are gear-operated. The predominance of heat, slag and steel dust naturally imposes the same severe requirements upon the lubricant as elsewhere in this part of the plant; as a result lubrication of gears and bearings often become quite a serious problem. If the gear compound as recommended for converter gears is used, with a good black oil for bearings and journals, many of the lubricating difficulties will be eliminated. In other words, the lubricant must resist heat and contamination with foreign impurities.

Ingot and ladle cars may be equipped with either plain journal boxes and brasses, or roller bearings. The latter are coming into quite extensive usage due to their savings in oiling labour, inspection and lubricants. While it might seem that such bearings would be subjected to considerable heat, we must remember that inasmuch as they are practically always in the open air, radiation can occur unhampered. As a result, such bearings, even before the ingots have solidified, will be comfortable to the touch. Hot metal, slag, dust, dirt and variable loads are usually the more important factors which must be considered. Especially are the former detrimental to plain journal bearings of the railway type because of the rough service and careless handling which is prevalent. In fact, journal-box covers either ajar, open or broken off, is a common occurrence. In the roller bearing, of course, the housing is tight and no carelessness can so disarrange it as to expose the bearing or lubricant to the detrimental action of hot iron, slag, dust, dirt or water.

Open-Hearth Plant.

In the open-hearth plant there is relatively little machinery requiring lubrication except the charging cranes, overhead travelling cranes, strippers, and operating mechanisms for raising and lowering the charging doors. In general, all equipment in this part of the plant which must be lubricated will be electrically operated. The overhead travelling cranes which serve for the handling of metal ladles are the most important hoisting devices involved; their uniqueness lies in their high rating, some running up to 200 tons capacity. All have at least two separate hoists, the minor or auxiliary being oftentimes as powerful as in the average crane found on other work. As

* From July issue of "Lubrication."

in the Bessemer plant, heat and contamination are the chief detriments to which the lubricants are subject. The cables, gears, bearings, hoists and trolleys of all these mechanisms are periodically exposed to the extreme heat of molten metal and hot gases which arise from the boiling steel during tapping. This is particularly applicable to the cables holding the hooks which raise the ladles. As a result, lubricants which are not specially refined will tend to dry up and lose their effectiveness rapidly.

In certain plants where induced-draft fans are installed to force the hot gases from the open-hearth through a series of waste-heat boilers, the lubrication of the bearings of these fans will often become difficult due to the heat from the hot gases which is conducted by the shaft to the bearing. These fans are usually motor-driven, being equipped with water-cooled, ring-oiled bearings. To meet the heat conditions properly and afford the necessary lubrication, a relatively high viscosity engine oil, or even, in some cases, a steam refined cylinder stock must be used.

Electric Furnace.

The usual mechanisms which will require lubrication in the electric furnace are the rack and gear teeth, the bearings of the operating motor and connecting rod and any other accessory journals involved. In general, heat conditions will not be quite as severe, nor will these mechanisms be subject to as dusty operation as elsewhere in the works. Therefore the usual lubricants specified heretofore for similar mechanisms will function with perfect satisfaction; in fact, lasting longer and giving better service than when operating conditions and temperatures are more severe.

High-Silicon Steel Rails.

There is a great deal of discussion in steel-making circles in Luxemburg concerning the contract for rails for the Belgian State railways. It is now some months since tenders were invited for large quantities of rails of about 106 lbs. per yard. The specifications drawn up by the technical experts of the Ministry for Railways were such that the accredited suppliers preferred to refrain from quoting. The clause relating to the chemical composition of the steel specified that the silicon content was not to be less than 0.25 per cent. The sulphur and phosphorus contents were dismissed with the short remark that they were to be as low as possible!

It appears that the Belgian rolling mills have already had most trying experiences with this steel, which is said to be most difficult to roll owing to the high silicon content. The Cockerill and Ougrée mills have only accepted orders for a few thousand tons. Other firms, like the Providence concern, have quoted prices 150 to 200 Belgian francs higher than their Luxemburg competitors, to indicate—so to say—that they were tendering as they were invited, but were not anxious to secure any order. One group, the Arbed-Terres Rouges, which obtained an order for 27,000 tons, had the unlucky experience of producing 1,000 tons of "wasters" out of a batch of 1,200 tons. What happens may be briefly stated as follows:—

The cavities and pipes in a carbon-steel ingot become welded together when the ingot is passed through the cogging mill. But this does not happen with the steel of high silicon content, with the result that a piped ingot splits, or "gapes," as the workmen say, and the resulting bloom is useless for rolling down to heavy rails. The engineers of the Arbed apear to have hit upon the idea of using these defective blooms (about 30 per cent. wasters) for rolling down to 40-lb. rails, or still lighter sections. The cases quoted are typical of the experience of the mills. The facts are freely discussed in Luxemburg, but their accuracy as regards details is not guaranteed. If the facts are as stated, the Luxemburg makers will be on their guard in future in respect of high-silicon rails, and confine themselves to quoting for rails of carbon steel only, which gives such satisfaction both in rolling and in service.

Another topic which is being discussed among the rail manufacturers and exporters in Luxemburg is in connection with a metallurgical problem that has been discussed widely and often—namely, the rolling of rails of two different kinds of steel. Without entering into details, it will suffice to state that the object to aim at is to produce a rail that should only be hard and highly resistant to abrasion on the top or running surface. Hardening the head subsequently to rolling is said to be impracticable because it would involve unequal cooling of the upper and lower portions of the rail, which would set up internal stresses seriously detrimental to the rail. Even were it possible to harden—by quenching—the head of the rail, the problem of producing a solid rail having a high-carbon steel head and a mild-steel web and foot is so far unsolved.

It is said that after some years of experimenting the Research Department of the Société Métallurgique des Terres-Rouges is upon the point of solving the problem of producing such an ideal rail. The rail would be rolled in two parts; the foot and the web would be of mild steel, whilst the head would be made of a very hard steel. The top of the web would be tapered, and fit into a groove in the bottom of the head.

Commenting upon this article, which appeared in a recent issue of "L'Usine," the Editor of THE IRON AND COAL TRADES REVIEW, says: "What will strike the reader at the outset is that the Administration of the Belgian State Railways should invite tenders for rails to a specification which no Belgian or Luxemburg steelworks are able, or perhaps willing, to comply with. As regards the alleged difficulties of rolling rails from a steel containing 0.25 per cent. of silicon, we need not remind our readers that the tonnage of rails rolled to Messrs. Sandberg's specification for high-silicon rails must run into six figures.

As regards rails built up of two parts, the idea is of course not new, but has not found favour anywhere, at any rate not during recent years or on any large scale. Moreover, there is no reason why this complication should be introduced into the design, as rails rolled in one piece can be subjected to the Sandberg process for producing a sorbitic structure of the steel which answers the purpose equally well if not better. On the Metropolitan District Railway such rails are reported to have shown a superiority of 80 to 90 per cent. over ordinary steel rails as regards loss in weight under heavy traffic."

Iron and Steel Output in August.

The National Federation of Iron and Steel Manufacturers report that the production of pig-iron in August amounted to 588,900 tons, compared with 615,600 tons in July and 599,800 tons in August, 1923. The number of furnaces in blast at the end of the month was the lowest since December, 1922. The August production included 187,400 tons of hematite, 183,700 tons of basic, 155,800 tons of foundry and 33,800 tons of forge pig-iron.

The output of steel ingots and castings totalled 527,500 tons, compared with 689,300 tons in July and 567,500 tons in August, 1923. The low output in August is to a considerable extent due to holidays.

New South Wales Iron and Steel Industry.—It is proposed to erect new iron and steel works at Port Kembla, on the coast south of Sydney, at a cost of about £2,000,000. The site is adjacent to coalfields, while the supply of ore will be drawn largely from the West Coast of Tasmania, but large quantities of flux and other materials will be obtained from the southern districts of New South Wales, which are to be connected with Port Kembla by a cross-country line of railway. This line has already been recommended by the Public Works Committee, and Parliamentary sanction is expected to be given for its construction during the present session. It is stated to be the intention of the company (the Hoskins Iron & Steel Company) to manufacture, as far as is practicable, the machinery for the new works in Australia from Australian material.

XUM

Trade Talk.

THE OFFICES of the American Chamber of Commerce, in London, Inc., are now at Aldwych House, Aldwych, W.C.2.

A LICENCE UNDER the Non-Ferrous Metal Industry Act, 1918, has been granted to Mr. J. J. Stevenson, 25, Sedgley Terrace, Walsall Road, Wednesbury, Staffs.

THE HEADQUARTERS of the British Sulphate of Copper Association, Limited, will shortly be Victoria House, Victoria Street, S.W.1, with Mr. W. J. Livesey, hitherto sales manager to the Mond Nickel Company, as general manager.

THE CHINESE ENGINEERING AND MINING COMPANY have received a cablegram from the Kailan Mining Administration stating that, owing to the preparations which are being made for war in North China the transport of coal from the mines has been stopped.

AT THE WEEK-END the steamer "Sally Maersk" arrived at the Senhouse Dock at Maryport from Marmagoa with 3,500 tons of ore for the United Steel Companies, Limited, at Workington. The ore traffic at this port has been slack for some time, and this is the first arrival since the beginning of the month.

SMITH BROTHERS & COMPANY (HYSON), LIMITED, engineers, iron and brassfounders, Hyson Green Works, Nottingham, have erected a new fitting shop and extended the machine shops at their Nottingham works, in order to cope with the demand for iron and steel valves. They are also installing machine tools especially adapted for valve work.

VICKERS, LIMITED, Hydro Electro Department, have received an order from the Government of New Zealand for two large water turbines, output of each 12,650 horse-power. These will be installed at Lake Coleridge in the South Island, and will provide power for Christchurch, Ashburton, Timaru and district. The turbines will be constructed at Barrow-in-Furness.

MR. G. O. B. WILLIS has been appointed manager of the Sheffield works of Henry Bessemer & Company, Limited. Mr. Willis has for a long time been associated with Cammell, Laird & Company, Limited, He was manager of the company's railway tyre department at Sheffield for many years, and later took over the managership of the steel furnaces at the new works at Penistone.

A CONTRACT FOR THE building of six ships has been lost by this country. The Shell Company have placed orders in Holland for six single-screw Diesel motor-propelled oil tankers. They reach 10,000 tons, and the total cost is over £1,200,000. Three of the ships will be built at Amsterdam by the Netherlands Shipping Company and three at Rotterdam by the Rotterdam Dry Dock Company. The contracts provide for only British steel to be used.

A COURT OF REFEREES has been held at Sheffield for the purpose of considering the claims of about 4,000 members of the Iron and Steel Trades Confederation for unemployment benefit under the Insurance Act. It was decided that the men were not members of the same grade or class as those engaged in the present steel dispute and that they would, therefore, be entitled to unemployment benefit. It was claimed that the men were not parties to the dispute and would not benefit by any settlement.

MR. T. F. HARDYMAN, after 15 years' connection with Petters, Limited, Yeovil, as foundry manager, has started a light casting foundry concern in Derby on his own account. He has been the recipient of handsome presentations from the officials and men. The directors have appointed Mr. L. B. Derry, late foundry manager to Peter Brotherhood, Limited, of Peterborough, to succeed Mr. Hardyman. Previously, Mr. Derry was associated with Crossley Bros., Limited, Belliss & Morcom, Limited, and Bumstead & Chandler, Limited.

A CONTRACT for 6,500 buffers has been received from the East Indian Railway Company by George Turton, Platts & Company, Limited, of Sheffield. Further orders for locomotive boilers have been placed by the Buenos Aires Railway Company with the North British Locomotive Company, Limited, Glasgow, and Kitson & Company, Limited, of Leeds, while Sir W. G. Armstrong, Whitworth & Company, Limited, have received an order for an additional four three-cylinder type super-heater locomotives for the Nigerian Railways.

THE STEEL HOUSE erected at Cathcart, Glasgow, has been visited by various deputations, on the invitation of Lord Weir, who indicated that if he received a contract he was prepared to erect 500 houses at £360 each. A further contract for 500 would be at the price of £330 each, while a larger number than that would cost £300 each. He expressed the hope that when the factory was in full operation the cost might be still further reduced. In these figures the cost of the land, roads, footpaths, and fencing was not included.

A COMPETITION was arranged by the Institution of Heating and Ventilating Engineers early in the year to encourage education in the industry. The result has now been issued by the Council of the Institution. Interest seems to have been awakened in different parts of the world, and the "Lumby" Premium, £10 10s., presented by Lumby's, Limited, of Halifax, was secured by an American, Mr. V. Nekrassoff, of Philadelphia, U.S.A. The "Sirocco" Premium, £10 10s., presented by Davidson & Company, Limited, Belfast, was awarded to Mr. V. Matthews, of Bristol, and the "Preston" Premium, £5 5s., presented by Mr. J. R. Preston, of Mumford, Bailey & Preston, Limited, London, was awarded to Mr. H. A. Stirzaker, of London.

Personal.

MR. A. NEVILLE CHAMBERLAIN, M.P., has now resumed his seat on the board of Elliott's Metal Company, Limited.

THE HON. HENRY DUNCAN MCLAREN has been elected a director of John Brown & Company, Limited. Mr. McLaren is the son of Lord Aberconway, chairman of the company.

MR. JOHN SAMPSON, engineer, and Mr. John Craig (of David Colville & Sons, Limited) have been elected directors of Harland & Wolff, Limited. Mr. Sampson was associated with the company for many years prior to Viscount Pirrie's death.

MR. J. W. BARBER has resigned his position with Stein & Atkinson, Limited, and has been appointed general manager to Christmas & Walters, Limited, of Caxton House, Westminster, London, S.W.1, the duties of which position he is taking up immediately.

Wills.

WESTLEY, C. H., at one time a brassfounder at Dudley	£54,642
PEARN, W. A., of Birchfield Road, Rusholme, Manchester, engineer	£9,173

Contracts Open.

London, E.C., September 27.—(a) Spring steel; (b) mild-steel plates and sheets; (c) M.S. angles, channels and bars; (d) best Yorkshire and grade "A" iron; and (e) girder bridges, for the Bengal-Nagpur Railway Company, Limited. The Company's Offices, 132, Gresham House, Old Broad Street, E.C.2. (Fee, 20s., non-returnable.)

London, S.W., September 26-November 14.—(1) Structural steelwork (consumable stores shed); (2) structural steelwork (yard plant); (3) screws, for the South Indian Railway Company, Limited. The Company's Offices, 91, Petty France, Westminster, S.W.1. (Fee, 10s. for (1) and 5s. each for (2) and (3), non-returnable.)

Clacton-on-Sea, September 30.—One 10-ton single-cylinder steam road roller with scarifier attached, etc., for the Urban District Council. The Surveyor to the Council.

Eccles, Lancs, September 22.—One 150-k.v.a. three-phase oil-cooled transformer, ratio 6,600/400 volts, periodicity 50 cycles per second, for the Electricity Committee. The Borough Electrical Engineer, Electricity Works, Cawdor Street, Patricroft. (Fee, £1 1s., returnable.)

Glasgow, September 19.—Heating boiler, for Springburn Baths. The Office of Public Works, City Chambers, 64, Cochrane Street, Glasgow.

Much Wenlock, October 1.—Sinking well, erecting pumping station, including provision plant and machinery and laying mains, for the Town Council. Mr. F. W. Derry, town clerk, Much Wenlock, Shropshire.

London, E.C., October 1.—Bogie rail and timber trucks, for the East Indian Railway Company. The Offices, 73-76, King William Street, E.C.4. (Fee, £1 1s., non-returnable.)

Judging Pig-iron by Fracture.

We regret that we cannot publish the several contributions to the discussion of Mr. Young's Paper on this subject which have reached us since the author has replied, as unfortunately they do not carry the subject any further, and some are purely an attack upon Mr. Young rather than his Paper.

IN 1923 the United States manufactured more than 260,000 tons of electric steel castings.

Company News.

Steel Products (Stores), Limited.—Net loss, £24,146. Total debit balance, £39,060.

Chesterfield Tube Company, Limited.—Dividend on 7½ per cent. preference shares for half-year.

Coltness Iron Company, Limited.—Half-yearly dividend on first and second preference shares.

Howard & Bullough, Limited.—Usual quarterly dividend of 6d. per share, less tax, on ordinary shares.

British & Helsby Cables Company, Limited.—Interim dividend, 1s. per share, less tax, on ordinary shares.

British Aluminium Company, Limited.—Interim dividend, 5 per cent. per annum, less tax, on ordinary shares.

Riley Stoker Company, Limited, Palace Chambers, Bridge Street, Westminster, S.W.—Engineers. Capital £12,000 in £1 shares.

E. & E. Kaye, Limited, Perseverance Wire Mills, Ponders End.—Copper wire manufacturers. Capital £20,000 in £1 shares.

Sheffield Forge & Rolling Mills Company, Limited.—Loss for year, £12,911; debit balance carried forward increased to £26,421.

Parker, Winder & Achurch, Limited.—Interim dividend, 6 per cent. per annum on preference shares and 5 per cent. per annum on ordinary shares.

Thomas W. Ward, Limited.—Final dividend, 6¼ per cent., tax free, on ordinary shares, making 10 per cent.; also 10 per cent., tax free, on new shares.

Elliott's Metal Company, Limited.—Net profit, £63,656; brought forward, £32,903; available, £96,559; dividend on ordinary shares, 2s. per share, less tax; carry forward, £41,000.

Robert Thornton, Limited, Paragon Wire Works, Roberts Street, Westgate, Cleckheaton.—Capital £7,000 in £1 shares. Wire manufacturers. Directors: P. H. Thornton and T. Thornton.

William D. Palmer, Limited.—Capital £2,000. Manufacturers of and dealers in air compressors and machinery of all kinds, etc. W. D. Palmer is chairman and permanent managing director, Caxton House, Tothill Street, S.W.

Cork Iron and Hardware Company, Limited, 16, North Main Street, Cork.—Capital £25,000 in £5 shares (2,000 preferred). Directors: J. E. Atkins, J. Wolfe, J. Moffett, J. H. Atkins, C. B. Roche, J. G. M. Buchan and J. M. White.

United Machine Tool Company, Limited, Holborn Hall, Gray's Inn, W.C.1.—Capital £3,000 in £1 shares, to act as agents in the United Kingdom, British Dominions, Colonies and elsewhere. Directors: J. Oekinghous (German), O. Doll (Austrian) and E. Reinecke (German).

Ferodo, Limited.—Net profit, £72,988; brought forward, £7,499; transferred to capital account, £7,400; available, £73,087; dividend, 10 per cent. on 7 per cent. preference shares; ordinary dividend, 20 per cent., and same on new ordinary shares; reserve, £15,000; forward, £7,779.

Gazette.

MR. J. J. OXLEY, trading at 13, Royal Buildings, Bigg Market, Derwent Water Chambers, 32, Sandhill, and 42, Baltic Chambers, Newcastle-upon-Tyne, engineer and merchant, is paying a first dividend of 1s. 3d. in the £.

MR. J. A. CRYER, carrying on business under the style of Cryer & Dawson, King's Court, Bingley, Yorkshire, machine tool maker, has been adjudged bankrupt. The public examination has been fixed for October 20 at the Bradford County Court.

Iron and Steel Works in Brazil.—From Rio de Janeiro, by mail, comes the interesting announcement that, acting upon recommendations of the Congressional Iron and Steel Commission appointed to report upon the state of these industries in Brazil, the Brazilian Government has decided to foster the establishment of three additional steel plants, each having an annual capacity of 50,000 metric tons. The plants will be erected in the Rio Doce Valley, the Paraopeba Valley and the Santa Catharina coal region. It is laid down that the person or company erecting such plants must be of Brazilian nationality, and possess an easily accessible iron or coal mine. Special privileges are promised in connection with the importation of the necessary plant and machinery, while the Government will lend to each plant-owner 80 per cent. of the cost of the erection and equipment without interest for five years, after which time the loan is to bear 6 per cent. interest. In addition to these advantages, the Government undertakes to construct or improve the necessary railways, to extend port and shipping services, and to afford other facilities that may be deemed necessary for the development of the coal and steel industries of the country.

Patent Specifications.

Particulars of complete specifications accepted, furnished by Mr. Eric Potter, Patent Agent, of Lonsdale Chambers, 27, Chancery Lane, London, W.C.2. Printed copies of the specifications in the following list are now on sale.

220,006. HADFIELD, SIR R. A. Alloys, Feb. 9, 1923.

220,011. AMBER SIZE AND CHEMICAL COMPANY, LIMITED. Manufacture of aluminium hydroxide. Feb. 27, 1923.

220,012. MARKS, E. C. R. Process of electrolytically refining tin bullion. Feb. 28, 1923.

220,119. BRITISH THOMSON-HOUSTON COMPANY, LIMITED. Enclosed metallurgical furnaces. June 22, 1923.

220,230. ROUSSEAU, G. E. C. Ore pulverisers. Jan. 21, 1924.

212,932. SOC. ANON. METALLUTIGIQUE D'AUBRIVES ET VILLERUPT. Casting machines for the manufacture of tubular metal articles by centrifugal force. Sept. 6, 1922. (Divided application on 203,688.)

220,336. GRIMES, G. L. Roll-over foundry moulding machines. Feb. 19, 1923.

203,708. MOND, A. L. Process for the production of aluminium-fluoride-alkali-fluoride double compounds technically free from iron. Sept. 8, 1923. Convention date not granted.

193,851. CHEMICAL TREATMENT COMPANY. Process of desulphurising iron, steel, ferro-alloys, and copper, and a composition of matter for use in the process. February 22, 1923.

220,670. BIDDER, M. McC. Apparatus for use in cutting metal by means of flame. February 23, 1923.

196,922. THAYER, R. Process of and apparatus for treating metalliferous pulp. May 1, 1922.

220,710. ETCHELLS, H., POPPLEWELL, A., and CAMERON & SON, LIMITED, L. Alloys. May 22, 1923. Cognate applications 13,945/23 and 17,465/23.

205,050. SERVAIS, A. Welding chain links, rings, etc. October 6, 1922.

220,766. BAZELEY, F. Coating articles or surfaces with sheet-metal veneer. June 29, 1923.

220,775. GREEN, S. EDEN. Rotating and self-adjusting clip for holding mineral specimens, etc. July 16, 1923.

220,791. DREIFUSS, M. Acid-proof alloys. August 1, 1923.

220,823. PRICE, G. B., and QUIRK, BARTON & COMPANY, LIMITED. Production of lead oxide. September 17, 1923.

The Application of the Ideal Solubility to the Interpretation of Equilibrium Diagrams in Metal Systems.*

BY D. H. ANDREWS, PH.D., AND PROFESSOR JOHN JOHNSTON, D.SC.

Summary.

The purpose of this Paper is to point out the applicability of certain deductions, from the laws of the ideal solution, to phase equilibra in metal systems, and to show the practical usefulness of these theoretical relations in helping to assess and interpret the experimental data. So far as the authors are aware, the method of plotting here discussed has not been applied to metal systems; indeed, some metallurgists appear to doubt the likelihood of any useful theoretical interpretation of these equilibrium curves. On the other hand, it is to be specifically understood that the simple mode of treatment outlined and illustrated in the Paper may not, in the present state of our knowledge, be used without qualification as a basis for the complete interpretation of all types of system; nevertheless, in many systems the simple theory fits the observations better than the authors had anticipated, and so it may at least be used as a guide in criticising and simplifying experimental work.

MR. GEORGE SMART, the sole agent for Scotland for Spermoline Limited, of Halifax, and James C. Waterhouse & Company, crucible manufacturer, of Wakefield, has changed his address from 95, Finlay Drive, Dennistoun, Glasgow, to Rowallan Stepps, near Glasgow.

* A Paper presented at the Autumn Meeting of the Institute of Metals.

IRON AND STEEL MARKETS.

Pig-iron.

MIDDLESBROUGH.—Although still much restricted in volume, the business passing on the Cleveland iron market has assumed a somewhat steadier tendency, and the tone throughout is not quite so pessimistic as has been experienced during the past two or three months. On home account the demand for foundry pig, though greatly below the average for corresponding periods, evidences a fairly steady rate of consumption, while inquiry for export, if still restricted, shows some slight improvement since last reported. These developments have had the effect of checking the downward tendency of prices, which remain practically unchanged at last week's levels. As regards stocks of foundry iron, these are reported to be of quite manageable proportions. Stocks of hematite, however, are heavy, and an outlet for these is badly needed. Shipments from the port of Middlesbrough for the current month are below those of August, the total up to September 16 being only 12,409 tons, as against 15,714 tons. Current quotations for the standard No. 3 G.M.B. quality are steady at 82s., with 6d. more for small lots. No. 1 is 87s., No. 4 foundry 81s., and No. 4 forge 80s. per ton.

It must be admitted that the hematite position is still very unsatisfactory, dependant as it is upon improved conditions in the steel trade. Values continue to fall, and still the point does not yet appear to have been reached at which any consequent stimulus has been given to the market. At this week's market East Coast mied numbers declined further to 90s. per ton, 1s. below the previous week's figure, with the No. 1 quality 6d. per ton more. In the North-West Coast area Bessemer mixed numbers stand nominally at 104s. per ton, delivered at Glasgow; 110s. per ton, delivered at Sheffield; and 115s. per ton, delivered at Birmingham.

LANCASHIRE.—The continued inactivity in the foundry industry in the district is having a depressing effect upon local market movements in foundry pig, large buyers of this quality iron contending that the price here ought not to be more than 90s., and some of them will not buy for the remainder of the year until it reaches that price. They are waiting for a further fall in the Cleveland iron market. The quotation for Derbyshire No. 3 foundry, delivered equal Manchester, still stands at 93s. 6d., while some small transactions in Scotch brands are reported at 109s. per ton, nominal.

THE MIDLANDS.—The more active buying movement recently in evidence in foundry iron in this district has subsided, leaving the position at present quiet, with hand-to-mouth dealing the general rule, quotations are practically unchanged as follow:—Derbyshire No. 3 foundry, 85s. to 87s. 6d.; Staffordshire No. 3 foundry, 87s. 6d.; Northants. No. 3 foundry, 80s. to 82s. 6d.

SCOTLAND.—Conditions in the local markets for foundry iron continue stagnant, and, if anything, business has shrunk to smaller dimensions, while the price of No. 3 quality is easier at 91s. 6d. per ton f.o.t. furnaces. There is more talk of furnaces being put out, and one of the makers have put their men on day-to-day notice. The price of No. 3 foundry Scotch for export is 95s. f.a.s. Glasgow.

Finished Iron.

Rather better reports are heard concerning marked iron. There is no great pressure of demand, but there has been an improvement and the mills are running steadier. Some of the increased trade has come from the railway orders given out in this district. Crown bar makers, however, do not seem to be in any better position; on the contrary, some of them are reported to have cut the price a little. Others still stand firm for the £13 basis, and confess that they have difficulty in booking orders at that price. Common bars at £12 remain much above the market level, which is still fixed by the Belgian quotation, but the most destructive effect is that of the cheap steel. Only a very limited quantity of iron gas strip is being made for a similar reason—steel strip is so much cheaper, and for many purposes, though not all, quite as efficient.

Steel.

Owing to current labour troubles the Sheffield steel industry may be described as at a standstill, and no improvement can be expected until the dispute is settled. In the market for semi-products British makers seem to have recognised the inevitable, as it were, and are not pushing soft billets, realising that they cannot compete with the Continental makers. They sell a very small quantity occasionally at £7 10s. The home trade at the moment is mostly confined to small sales of carbon and other special billets at more remunerative prices. In ferro-manganese there is only a hand-to-mouth business being done at present, and conditions are much the same as last week. There are no fresh features to report in the tinplate trade, though the tone is firm, with makers in some cases holding out for just a trifle over the new minimum rate of 23s. 6d. basis I.C. f.o.b. Bristol Channel ports.

Scrap.

Corresponding in conditions with the general state of the iron and steel trade throughout the country, business in scrap metal is similarly situated, with buying on an extremely limited scale. The Lancashire market for foundry scrap is very dull, and only a small quantity can be sold. Dealers are trying to keep the selling price up to 85s. for good broken machinery castings, but 82s. 6d. has been heard of, and it is doubtful whether much could be sold even at that low figure. There is perhaps a chance that, with the improvement in the cotton trade, a better demand may occur for new machinery, and if the textile engineers get busy again there will be more demand for the best qualities of cast scrap; otherwise there would seem to be little prospect of an early improvement. In the chief Scottish markets business in this material is also quiet, with machinery cast-iron scrap in pieces not exceeding 1 cwt., suitable for foundries, still quoted at 87s. 6d. to 90s. per ton. Ordinary cast-iron scrap to the same specification is 82s. 6d. to 83s. 6d. per ton, and cast-iron scrap to steelworks specification—i.e., in pieces not exceeding 5 ft. by 2 ft. by 2 ft.—82s. 6d. per ton. Old cast-iron railway chairs are still 85s. to 87s. 6d. per ton. Light cast-iron scrap is 70s. to 72s. 6d. per ton, and if mixed with firebars 2s. 6d. less.

Metals.

Copper.—A somewhat easier tendency in values of standard copper has been apparent of late, and with a partial subsidence of speculative interest, market conditions are for the moment without outstanding features. Although from all reports there is an improvement in the demand from American consumers, so far as can be gathered the eagerness of dealers to dispose of their holdings acquired recently on cheap lines has been such as to prejudice somewhat the attitude of trade buyers, while producing interests have at the same time indicated willingness to make slight concessions in order to capture orders. Current quotations:—*Cash*: Thursday, £62 5s.; Friday, £62 5s.; Monday, £62; Tuesday, £62; Wednesday, £62.

Three Months: Thursday, £63 5s.; Friday, £63 5s.; Monday, £63; Tuesday, £63; Wednesday, £63.

Tin.—Confidence in this section of the metal market experienced a decided set-back last week, consequent upon an aggressive bear movement, the resulting fluctuations in values taking a somewhat serious range in a downward reaction. Advices from America indicate that the tinplate industry there is going ahead again, and thus the American users should be heard from shortly. The last month's visible supply statement showed that there has been an increase of about 1,000 tons in the visible supply, but the Eastern pooled surplus is becoming worn down very considerably, and another three months will see this finally dispersed. Current quotations:—*Cash*: Thursday, £235 10s.; Friday, £233 5s.; Monday, £227 15s.; Tuesday, £227 15s.; Wednesday, £233.

Three Months: Thursday, £237 7s. 6d.; Friday, £235 10s.; Monday, £229 10s.; Tuesday, £229 10s.; Wednesday, £235.

Spelter.—The market for this metal continues somewhat unsettled, with values fluctuating, but fairly firm on the whole. American reports are better, with talk of a large order for South America for galvanised sheets. Zinc has been arriving here from the United States unsold, and there is not much eagerness among dealers to do anything. Current quotations:—*Ordinary*: Thursday, £32 17s. 6d.; Friday, £32 16s. 3d.; Monday, £32 12s. 6d.; Tuesday, £32 7s. 6d.; Wednesday, £32 5s.

Lead.—The demand for soft foreign pig is steadily maintained, the electrical and building industries taking satisfactory quantities of the metal, whilst manufacturers of lead sheets and pipes are increasing their outputs month by month. Current quotations:—*Soft foreign (prompt)*: Thursday, £32 15s.; Friday, £33 2s. 6d.; Monday, £33; Tuesday, £32 15s.; Wednesday, £32 17s. 6d.